FACTORS AND IMPACT OF PARTICIPATION ON THE OPERATION AND MAINTENANCE OF AN IRRIGATION SYSTEM IN NEPAL: A CASE STUDY OF THE BABAI IRRIGATION PROJECT

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in
Natural Resources Management

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May 2009

Acknowledgements

The author wishes to expresses sincere gratitude to Dr. Sylvain Perret, Chairman of the Thesis Advisory Committee and academic adviser, for his valuable guidance and encouragement throughout the study period. The author is also grateful to the thesis advisory committee members Prof. Ganesh Prasad Shivakoti and Dr. Roberto S. Clemete for their advice, suggestions and creative criticism during his study.

The author expresses acknowledgment to the Austrian Development Agency-ADA for sponsoring the study and also providing the research grant. The author is greatly indebted to CIRAD (Centre de Cooperation Internationale en Recherche Agronomique pour le Développement) for the research grants provided in completing the research field work.

The author is grateful to Rural Reconstruction Nepal–RRN, especially to Dr. Arjun Karki, President, Dr. Sarba Raj Khadka, director and Dr. Rishi Adhikari for recommending him to pursue this study. The author is also grateful to Asian Institute of Technology for providing opportunity for his study, and NRM field of study family for their help during the study.

It is indeed very pleasant to express thanks to Mr. Ratna Karki for advice and directly or indirectly support throughout the life to come up to this stage. Special thanks are also extended to Mr. Dayaram Khadka, Chairperson of Babai Irrigation System (BIS) and other committee members of the BIP for their help at the study area. The cooperation of the local leaders and all the farmers in the study area are commendable as well.

The author is very thankful to khun Jitra, Khun Sumaleeep, Khun Nikorn, and Khun Vitoon for their support during my study. The authors also expresses thanks to all the colleagues who supported directly and indirectly during the study period.

The author is very grateful to his family members including father, mother, sister, and, brother, for their support and love in different mode of life. Finally, the author feels proud to express sincere gratitude to his wife Pratima Pokharel for her love, encouragement and support throughout the life. This work is dedicated to the beloved son, Ashraya Gyawali, of the author.

Abstract

The operation and management of irrigation systems is an important concern in Nepal. In this context, the level of participation of the farmers and the factors influencing become very crucial. The overall goal of this research was to identify and evaluate motives, factors, constraints and opportunities for farmer to participate in the management of irrigation schemes, in order to suggest recommendations for improving efficiency of farmer-managed irrigation systems. This research was conducted in Babai irrigation system from Western plain area of Nepal. It covered only the right part of the irrigation systems which managed by farmers. Qualitative as well as quantitative data were collected using in-depth interview, focus group discussion and the structured questionnaire with randomly selected 134 households in the irrigation system.

The study revealed that huge number of the sampled household's dependents on agriculture in term of employment. The cropping intensity was not significantly different across different parts of the irrigation system; whereas it differed across different farm size. The result showed that the productivity of major crops (Paddy, wheat, maize and mustard) was significantly higher in Type-I farmer (full-time farmers) compared to others. Similarly, significantly higher level of paddy productivity was found in head-end area of the irrigation system; and with higher farm size. The economic efficiency measured in terms of gross and net income was higher in head-end area, Type-I farmer and with large farm size. The principal component analysis carried out to identify essential interrelationships of various factors influencing farmers' participation in irrigation management.

The result showed that the response of operational activities for acquisition of water was significantly higher in head-end area of the system. Similarly, the satisfaction level was significantly higher in the head-end in case of the allocation of water among branches and the distribution of water. But in terms of the application of water the satisfaction level was significantly higher in the middle of the system. People from the Babai Irrigation system were found to be usually participating in different community activities. In case of construction and development activities the highest degree of participation was observed in case of farmers with medium farm size whereas in case of social campaign the farmers from large farm size were found having higher level of participation.

Based on the findings, we can suggest that farmers' participation in operation and maintenance of the irrigation systems can be boosted by increasing their involvement in decision making process of the operation and maintenance activities. Farmer participation seems to be crucial for improvement of irrigation water management and agriculture production. Analysis describes that availability, reliability, adequacy and equitability of water are fundamental factors to ensure effective and successful beneficiary's participation in farmer managed irrigation system.

Key words: Irrigation, Participation, Livelihood, Operation and maintenance, Management, Principle component analysis, Water User Association, cropping system

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List of Abbreviations

ADB/N	Agricultural Development Bank, Nepal
BIP	Babai Irrigation Project
DHM	Department of Hydrology and Meteorology
DIO	District Irrigation Office
DOI	Department of Irrigation, Nepal
FAO	Food and Agriculture Organization
FMIS	Farmer Managed Irrigation System
FIWUD	Farm irrigation and Water Utilization Division
GMIS	Government Managed Irrigation System
IMC	Irrigation Management Center
IMP	Irrigation Management Project
ISF	Irrigation Service Fee
IWMI	International Water Management Institute
O&M	Operation and Maintenance
BIP	Babai Irrigation Project
WUA	Water Users' Association
WUG	Water Users' Group
WUCC	Water Users Branch Committee
HHs	Households
ICIMOD	International Centre for Integrated Mountain Development
IMT	Irrigation Management Transfer
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture, Nepal
MoF	Ministry of Forestry, Nepal
MoPE	Ministry of Population and Environment, Nepal
NGO	Non Government Organization
NPC	National Planning Commission, Nepal
PIM	Participatory Irrigation Management
UNEP	United Nations Environment Programme
UNRISD	United Nations Research Institute for Social Development

CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture sector is the backbone of economy of Nepal. Irrigation plays a crucial role in the development and sustainability of agriculture. Though, agriculture shares large portion in the gross national products, the development of irrigation has been paid less attention than required. The agriculture sector in the country is still largely dependent on rainfall. Continuous periods of drought and excessive rainfall have troubled the yield of agriculture products whereas; the rapid growth in population has increased the demand of food which is needed to be supplied from the import from other countries. In such situation is important to improve the irrigation sector to maximize the production of available natural resources throughout the country.

Nepal is still in the stage of developing more than 86 percent of people are residing in rural areas. As agriculture accounts for around 40 percent of gross domestic products therefore it is considered the backbone of economy in the country. More than 80 percent of population is directly or indirectly reliant on agriculture activities for deriving their livelihoods and around 80 percent of them have been categorized to be subsistence farmers. Currently agriculture is the only sector engages huge number of people from many years compare to the other sectors in the country. Improving the agriculture sector can be the only possibility to achieve the national goal regarding the poverty alleviation. The development of agriculture will also leave positive impacts on the distribution and other adjacent problems in densely populated country. Currently the people involved in agriculture activities are employed for only 6 months in a year due to lack of irrigation water availability to meet the demand. Poverty alleviation is possible if the agricultural reliant communities were provided opportunities of full employment through efforts in irrigation development by the concern authority.

The irrigation development process of Nepal can be divided in to four different stages of development as described below (Shah 2001).

1. Before the mid of 1950s, various irrigation facilities were developed by farmers in terai and hills regions by using the available resources. These systems were managed by established groups of farmers according to their own rules and regulation developed by them. The main objective of these systems was to provide additional irrigation support to the paddy crops especially in monsoon months.
2. From 1956 to 1970, the infrastructure of irrigation scheme was highly focused by the implementation of different government funded projects. The traditionally constructed systems were further developed by construction of wide range of weirs and main canal to provide additional support to irrigation systems during monsoon period.
3. During 1970 and early 1980s the efforts were made to expand the construction and rehabilitation of irrigation systems in the command area managed by farmers.
4. From 1980s till now integrated development of water resources and land have been mainly focused by the concern authorities as following:

- Expansion and rehabilitation of FMIS by involvement of users.
- Development of groundwater irrigation projects in areas of seasonal supply of surface water
- Development of modern technology in agriculture sector
- Including of non-governmental organizations during different implementation activities

The idea of decentralization in management of irrigation system varies from participatory irrigation management (PIM) to irrigation management transfer (IMT). The participatory irrigation management is referred to some features of management of irrigation system as well as responsibilities of users and authorities to some extent. The irrigation management transfer is the totally handover the responsibilities of management of irrigation system to the water users associations at local level by government (Svendsen et al., 1997, Meinzen-Dick et al, 1997).The decentralization of irrigation management system intends to improve meaningful participation of users, (Rasmussen and Meinzen-Dick, 1995; Ostrom, 1990; Wade 1988) and it usually involves the formation water users association (WUA). It was mostly due to the need for formal rules and procedures for water allocations and collection of the water charge (Knox and Meinzen-Dick, 2001). In many countries WUAs are primarily responsible for management of either whole small-scale irrigation schemes, or local sub-systems located in large-scale irrigation systems. The ideas to design the modern WUAs have been drawn from research on traditionally constructed small-scale FMIS during 1980s (Ostrom, 1990; Wade, 1988).

The low performance of governmental irrigation organizations and weak setup resulted higher costs in operation and maintenance of irrigation systems in various countries. The governmental irrigation organizations have been failed to accrue enough revenues to finance O&M expenditures. The weak financial background along with higher O&M expenses caused many governments to handover the management of irrigation systems to local water users associations (Johnson et al., 1995). The struggles of handover the responsibilities of irrigation management to the local water users associations have led to reduction of government expanses (Shah et al., 2001; Meinzen-Dick and Knox, 1999; Kiss, 1990). These struggles also mentioned facts that the local users are capable of mobilization and management of resources more effectively on sustainable manner (Meinzen-Dick 1999).

1.2 Statement of the problem

The state owned enterprises has shown poor results in achieving physical targets and exploring modern approaches. The major causes for this were weak planning, low capacities of implementation and avoiding O&M (ADBN, 1982). Particularly the irrigation sector is limited by deficiency of human capacity, deficiency of procedures, government usually favours political relations during the implementations programs and local level government offices are not capable to support local participation and improve the technical situations. The government is lacking of resources to setup and achieve full potential. On one hand the lack of capacity to efficiently organize the resources and on the other hand the demand increases gradually be local people. The reasons are that enough aid was provided to improve the irrigation system which was considered to be highly needed along with growing demand. The irrigation development was considered very passively accompanied by lack of enough engineering skills which can be fulfilled by trained technicians.

Beside the increasing awareness issues regarding the participation of beneficiaries, more emphasis should be given to the action based research related to development of irrigation system are required. A core and widespread concern of in irrigation water distribution is "who gets, what and where". This is essential political concern but unfortunately very strange that no politician, policy makers and political scientists have been paid attention to this issue. It is clear that the water is limited and when a user or group of farmers compete for water; the attention mainly stays on process of distribution and acquisition specifies the accessibility of farmers to it. The irrigation schemes without proper management achieve the desired yield of agricultural productivity. O&M of a governmental managed irrigation system is important matter of concern. Usually with increase of development goal in past years but the allocated budget to operate, maintain the irrigation system was not increased to meet the expenditures. The irrigation projects have been increased but the fund to operate and maintain was not shown any growth. In most cased in Nepal irrigation service fee (ISF) can meet only small portion of expenses used for irrigation management (Barker and Lohani, 1987).The constraints of financial resources such as allocated budget to operate and maintain the irrigation scheme has shown following problems:

- Reduction in efficiency of irrigation system
- Inequity problems during supply of water to all users in area under coverage
- Decline in the agriculture products of the farmers

Whereas, the government built irrigation schemes were operated and maintained by government agencies with less participation of beneficiaries in various development stages. As a result of low participation of the farmers there were no feeling of the ownership with misutilization of irrigation system which further caused the damage of the infrastructure, conflicts among farmers and groups of farmers due to inadequate allocation, distribution of water and irrigation related services. These activities have been occurred each after the other with negatively affected the performance of irrigation scheme (IMC, 1990). The discussion carried out highlights different consequences of farmers managed irrigation system with higher participation and centralized irrigation system with less or without participation in the management process of irrigation system (Table 1.1).

Table 1.1: Consequences of participation and non-participation

Participation	**Non- participation**
Proper management of operation and maintenance of the irrigation scheme	Weak management of operation and maintenance of the irrigation scheme
Higher water equitability and distribution at scheme and catchment level	Lower irrigation service fees collection
higher user participation in system implementation or improvement leading to feelings of ownership among the users	Conflict takes place among users in head and tail reaches of the irrigation system due to water allocation.
Increased capital cost recovery and effect better cost recovery for O&M	Management and misuse of irrigation systems which affects the farmers in many aspects such as maintenance cost, economic returns, water loss and etc
Decreased incidence of water fee misbehavior and maximize irrigation service fee revenues	5. Inefficient management of irrigation system due to lack of assistance from concern authorities at different level

Recognizing the realities the government has focused on the need of higher contribution of farmers through participation in different development stages of irrigation management to assure better performance, efficient mobilization of resources, conflict resolution causing due to inequitable distribution and allocation of water, maximizing the agriculture return, and operation and maintenance on sustainable basis. The idea of participation in not only emphasizing on participation of people's but it is also important to know the type, level and where to participate. The question arises that whether an initiative would be capable to provide financial support to operate and maintain the system by mobilizing the locally available resources, and how can be the participation created among the farmers in the system (Irrigation policy, 1992).

1.3 Research question

This study aims at answering the following research questions.

- What are the factors affecting people's participation in operation and maintenance of irrigation?
- How the users differ in the socio-economic characteristics and how these categories participate or not to irrigation management?
- To what extent does participatory management of irrigation systems improve outcomes (economic efficiency, equity, etc)?

1.4 Objectives:

The overall objective of the study is to identify and evaluate motives, factors, constraints and opportunities for farmer to participate in the management of irrigation schemes, in order to suggest recommendations for improving efficiency of farmer-managed irrigation systems.

The specific objectives are:

1. To describe/document the agricultural production systems in Babai irrigation system
2. To examine the factors affecting farmer's participation in operation and maintenance of the irrigation system
3. To assess the extent and prospect of participation of beneficiaries in operation and maintenance of the irrigation system
4. To suggest recommendations for improved participation in management and maintenance of irrigation system based on the case study findings

1.5 Scope and Limitations

This study is concentrated on the various management phases of irrigation in selected irrigation scheme. Following are the main focused areas of this study:

- Evaluated the policies and activities of governmental agencies particularly operation and maintenance, management and water users participation in irrigation scheme
- Encouragement and participation of water users in O&M of the scheme and resource mobilization as well
- Organizations involved in operation and maintenance of the scheme
- Various process of operation and maintenance activities in the irrigation scheme

The study is mainly concentrated on various phases of management of irrigation system such as behavior, opinions and views of beneficiaries which was generated through household surveys totally based on information from respondents. The outcome of the study can be limited to the specific aspects rather than generalized. Furthermore, this research is carried out as a case study for an irrigation scheme, so the findings of this study may not be applicable in management of irrigation systems in other regions of Nepal.

1. Availability of data from line agencies based on different time periods
2. The study will be conducted taking in to account only one irrigation system in Nepal
3. Selection of crops, cropping patterns, intensities, production and economic return will be focused at farm level
4. Organizational features were concentrated regarding the different process of management of water users associations and other related organizations at community level which are considered as the core components in the system and their roles, responsibilities and regulations of the related issues.
5. The primary data was mainly generated from household survey whereas the secondary data was collected from department of irrigation and other related agencies

CHAPTER 2

LITERATURE REVIEW

2.1 Irrigation management and people's participation

The management of irrigation system deals with the methods of utilization and distribution of irrigation water for on-farm application efficiently. It is essential to be considered in all type of irrigation systems, means that efficient distribution of water cannot be assured with the physical infrastructure only apart from users the other agencies involved, like planners, operators in the irrigation system for efficient and effective control on the use, distribution and proper allocation of water for different cropping pattern for optimization of outcomes is high dependent on proper irrigation management systems (Pise, 1980).

The main objective of the operation is to channelize all the necessary steps involved from the discharge of water from any sources, its proper allocation, timely supply and flow to the proper target area. The regularity, sustainability and well functioning of whole process can be said as maintenances (ASCE Manual no. 57, 1980).

According to Uphoff in 1986 for overall irrigation management system it essential to pay attention various on basic issues such as; water, b) physical structure responsible of the allocation, distribution, collection and flow of water, c) and activities which are interactive and mutually dependent usually managed by social organization.

The irrigation systems are usually running with the co-operation of agencies and direct beneficiaries, by assigning various responsibilities to technical and skilled persons and farmers. It is a co-management system the agencies are usually involved in technical issues while the users are given simple responsibilities at field level. If the people are assigned responsibilities at high level whether it is useful or not? There are couple of issues which are focused during the allocation of responsibilities to different levels for example government policies, size and nature of irrigation system, historical background of area traditions of people, level of skills and capacities of people and public administration and sources of supply of water. (Uphoff et. Al 1986).

The "Participation is the act sharing in the activities of a group or the condition of sharing in common with others (as fellows or partners etc.) (WorldNet Dictionary, 2004)" the act of development of rural people especially involvement of those groups which were not benefited from any activity implemented in the past is called people's participation. People's participation is an effective process which takes into account the programs planned and designed and carried out by themselves with significant impact on development of rural situation (FAO, 1997).

Dale (2000), states that the participation encompasses the issues which are given as under

- As contribution: Its is expressed that it can be thoughts, opinions, assets, capital skilled and unskilled personnel
- As organizing: It allows the people to take part in the development activities efficient with more interest if they were organized properly. It is said that good the participation has positive effect on the output organization and it is expected that it will result the allocation of resources will effect best management, and

- Participation as empowerment: empowerment of organization is always priority and essential for an organization. In fact the organization activities must be people-centered.

In all development activities the process of participation is becoming a standard off-course in irrigation and other relevant sectors. International commission on irrigation and drainage, development banks and other donors are struggling to encourage this process in irrigation relevant issues as well. Their struggles are supported through educational and research organizations such as International Water management Institute. The irrigation management related issues are replaced by participatory irrigation management by experts around the word in many debates. These debates will have sustainable outcome for those involved in it (Riddle, 2000).

The precipitation irrigation management (PIM) is an approach which involves the local people to take active part in the management of irrigation system and increase their productivity on sustainable base. It means that PIM allow the local farmers to be responsible for operation and maintenance related issue in the irrigation system. PIM gives the opportunity to the farmer council in various decision making and empowerment of the council1997 and 1999).

The idea of participation has been identified differently in according to timeframe. In a recent UNRISD overview of many studies on participation in relation with food policy and hunger Solon Barraclough, pointed out UNRISD researchers in many places identified that participation was specified in the development literature. These concepts were similar to some extent but opposing sometimes. The UNRISD researcher agreed upon some definition for popular participation in case of participation of the poor in mind. The organized efforts to increase the control over resources and regulative institutions in given social situations, on the part of groups and movement of those hitherto excluded from such control (Pearse, 1980).

Participation remained the language of development from long ago. Action research is one the main study process which is considerer to scope for the methods of soliciting meaningful participations after many carried out. There are two main social model recommended for underling methods of participations. First enlightenment and second social engineering models (Uphoff, 2005). The first one or enlighten model concentrates education and knowledge of individual regarding the development process classified as an evolutionary approach. This method is functional and helpful in long run but without guaranteeing that the knowledge can also be use for realizing the social action. The second model concentrates on social dynamics and fabric. It creates the conditions for using knowledge to purposively manage social action. This approach is used to deal with criticism of social management. The people trust that the evolutionary approach are doubter and thinks that “professional experts” or “master models” are not valued by local people and thinks that development programs as type of charitable welfare(Holloway, 1989). Though the model can be modified or developed to shape the connection among development agencies and goals with higher identification of ethnics (Cernea, 1993).

Participation, in case of considering different interdependent partners during a decision making process, participation allows to communicate the issues, requirements and problems, exchanging ideas, communication promises making. This will result the reduction of misunderstandings and will sustain the use of resources more vigorously. It doesn't say that the system should be completely managed by the farmers. It will be very useful for the system to be controlled by the government in some big projects. In local management system of agriculture development programs great decision are necessary to be taken by the states. Participation says that the farmers will take part in the design of agriculture initiatives at local level, where they have more knowledge comparing to the technical people which are not directly involved in those activities (Uphoff, Cohen, Goldsmith, 1979).

Community organizing is the approach encouraging the decision making and improving the skills of the community. It is based on participatory approach which encounters all relevant partners, this will lead to empower and encourage the communities.

In irrigation management community organization means to sustain and optimize the water use. Farmers and local authorities should participate actively in different stages of the system; furthermore it ensures cooperation and trust among all partners (Brink, 1997).

The process of development requires people to know to solve their problems by sharing or issues with parties involved in the process. Eagerness will be important to the successful participation process which will lead to achieve the target and finally activity the main goal by participation by the people and completely for the people (Cidse, 1993).

The capacities of individual families may not be at a certain level to build, operate and maintain even small level agriculture projects on sustainable bases, it is highly required that the farmers should be able to know the operation and maintenance part along with coverage of the cost after the projects are constructed. This encounters the cooperation between beneficiaries and authorized local leadership. Strong commitments and interest of beneficiaries to the projects is important for sound cooperation. Contribution to the project cost and foundation of village organization for management of this financial contribution is the signs of strong commitments and interest (Himel, 1996).

In Nepal the linkages among irrigation activities and gender issues resulted from different projects are identified as changes in agriculture practices, availability of basic resources, active involvement in community based organizations and situation of household leading by female.

This method should not be appreciated by irrigation interference. It may result that female farmers will not actively participate in the process of irrigation development issues if only men are considered farmers and involved in discussion of related issues. This will also have adverse effect on the on controlling their activities and valuable product of irrigation of female farmers in Nepal (Sonja and Ahlers, 1995).

During discussion on the capabilities of water releasing in a project men identified many issues regarding sufficient amount of water availability to allocate a timely start of the region. Women expressed the issue differently than the men did they also focused on the value of water availability in a season (FAO/IIMI, 1994).

2.2 Irrigation system operation and maintenance

The operation and maintenance usually called management stresses on regular distribution of water in a system and between farmers. Administrative duties, maintenance and repair of canal structure are also included in management (Bhuiyan, 1978).

Several points have been highlighted that which portion of the system should be given more importance to gain the expected result from the system which was shown during designing process. Most of the studies regarding the improving the situations have been carried out on on-farm stages. It was concluded that essential steps for more improvement at terminal level operation and maintenance is similar and based on movement of water in the main system (Lazaro, Taylor and Wickham, 1979).

If timely profit from the irrigation system is achieved by a specified target community in this case the operation and maintenance are important to take place to confirm the availability and dependency of water supply, at the tail region the users obtain required amount of water fairly, the salinity and water logging problems are not existed due well functioning of drainage (Biswas, 1990). The irrigation water-distribution system is called successful if the proposed objectives of water release are achieved through proper supply of water in fair and effective ways benefiting from the system (Molden and Gates, 1990).

Wickham and Valera (1979) highlight the portion of delivery system which affects the output of system, they found out after conducting a study on a project in Philippines that not only the on-farm allocation of water should be efficient for optimal outcome from an irrigation system but there should be equity and reliability in allocation in of water in each delivery system.

2.3 Contribution of farmers in performance of irrigation system

Israelsen and Smith 1965 carried out a study on several projects operating by people with very low level of knowledge and technical skills from many years in West Pakistan to find out that the amount of water distribution is fair. The outcome from such situation was water logging, less irrigation, soil erosion and widening of agriculture land which caused decline in production and efficiency.

Various studies based on farmer managed systems in Nepal have shown that it is not enough to say that the local communities have the capacity of organizing huge quantities of resources to build and mange their systems only but they have also the capacity to operate the system efficiently resulting high cropping intensity and net outcome. The farmer organization showed good results in activities such as on time water supply, distribution and allocation of water and supervising as well as the construction activities (Martin and Yoder, 1983). It has been noted that the project managed by farmers and developed with the assistance of government (with support of FIWUD, ADB/N and CARE/Nepal) have effective and productive result (Shivakoti, 1991).

It has been stated by Bautista in 1984, the equity of distribution of water has been improved by participation of irrigators association in magat river Multi purpose project in Philippines. This was also helpful for national irrigation authority (NIA) in collecting the fee from the users. Water users association have developed and adjusted their local irrigation institute gradually couple of years ago and worked out to improve its skills and

capacity renovate and overcome the situation in two low land villages of central Java. Recently it has been found out that the association is capable to gain the equalizing and production targets (Duewel, 1982).

Farmers participation is not only helpful in irrigation system's sustainability, managing their resources for proper operation and maintenance and efficient running of system but also creating the idea of ownership of the system to all farmers (Uphoff, 1986).

A.Bottral in 1981 stated that the causes of inefficient preference of irrigation system are resulting lack human capacities in planning and management process. The inefficient management of irrigation system can be clarified from two sides.

a) Lack of technical knowledge which results improper design and operation and maintenance to weak framework and action at users level and
b) Lack of people's participation resulting from socioeconomic insufficiency

Only partly explanation of weak water management system of irrigation scheme due to lack of technical knowledge (FAO, 982). The famer's management and polar alternatives of agency are not similarly realistic. Irrigation system in an area which is completely managed by agency is hypothetical in many portions. Skilled people can manage higher level of system operation by themselves instead of external agency, but infrequently are there enough human power, resources and information available to them to properly distribute and manage the water at the tail end farmers fields (Chambers, 1980).

It is extremely important to improve the operational efficiency of irrigation system which is resulting in high economic earnings to the inputs provided. This needs more focus on management side of irrigation comparing to the engineering side. Three important things must be clarified are: a) Financial support for O&M , b) improper use infrastructure and c) elasticity in operation for diversification of crops. Supplementary spending on irrigation may not be justified properly if the operational efficiency in an irrigation system is not improved. Therefore the government, donor agencies and beneficiaries are required to work jointly to formulate new policies and management approaches to make sure the availability of fund and manage in with kind of methods to increase the returns from system constructed with a huge amount of capital (Johnson, 1989).

More participation of local farmers in operation and maintenance issues and water users organization not only covers the costs by themselves but are also useful in proper mobilization of available resources organizing labor related activities and assures more contribution in relevant activities (Coward, 1976).

The Chhatis Mauja Irrigation System of Nepal which is designed and constructed over one hundred and fifty years ago covers an area of about 3000 hectares under the management of three-tiered structured organizations. This irrigation system shows the level of skills and capacities of farming communities with very low literacy rate consisted of fifty four committees on village level, nine committees in different areas and one main committee. The operation and maintenance activities of main canal are carried out by officers assigned by 4000 farmers with the contribution of 60,000 man- days of labor from various communities annually. For the operation and maintenance of branches and channels additional labors are contributed by local communities as well. The total costs such as remuneration of skilled and technical staff employed by organization involved in operation

and maintenance is covered by the direct beneficiaries themselves means that the government is exempted from all types of operation and maintenance costs (Pradhan,1983).

2.4 Participation segmentations and Water users Associations (WUA's)

Mostly individual farmer and scheme authority has a contact through many types of committees and board. The members of these committees are elected or appointed from farmers and scheme workers segments. Usually these segments deal according to the geographically restricted area with in the schemes. “Mostly WUA's focus on the improving O&M practices and organizing water courses to improve the irrigation system. Many of them are initialized by the government. These associations are supposed to obey the scheme authority which is responsible for providing technical help and materials. One such example is that of Taiwan where all irrigation activities are done by autonomous irrigation associations. All technicians and other officials are employed by the association. These associations have two bodies in order to perform the tasks. One is general body and the other is executive body. General body has 15 – 55 representatives from farmers; it depends on the size of the area, whereas executive body operates from a main office which recruits many regional and field officers. Teams consisting of farmers do collaboration in agriculture and irrigation practices and responsible for water scheduling and delivering, maintenance, repair and collection of fee. Water User Associations are responsible for a wide range of management activities e.g. these organizations distribute water shared by a group of farmers” Meinzen-Dick (1997)

Identifies two broad categories of WUAs: the Asian model and the American Model, the Asian model include farmers in smaller organization units allowing direct participation of all farmers based on social boundaries where as the American model relies on specialized, formal irrigation organizations based on hydraulic boundaries. The American model provides some special water rights to farmers (e.g., Columbia basin and Mexico), whereas the Asian model emphasizes to a greater extent on the formation of social assets.

Water Users Associations try to reduce the costs of implementing water pricing for instance monitoring and enforcement costs. There are many factors that can effect the capability of WUA e.g. property rights. The relationship among the irrigators depends on the creation and ownership of irrigation property like conveyance structure, pumping equipment etc. Well-defined water rights give farmers incentives to participate in the operation and maintenance of their water supply system. These rights can be assigned to individuals or to groups of farmers, such as WUAs. The activities of these kinds of associations provide economic advantages which include both increasing supply efficiency and production efficiency. For instance, due to the transfer of control from center to WUAs, the O&M fee collection and provision of irrigation services have been increased in Mexico and Pakistan (Johnson, 1997; Svendsen and Nott, 1997).

The strength of these collective action institutions is directly related to water scarcity Easter and Welsch (1986). The capability of WUAs is also affected by the size and location of the irrigation system, relatively equal income distributions and freely available information on irrigation technology. The effect of user based allocation on water conservation depends on the strength of local institutions (Easter, 1999). The review of successes and failures of WUAs with respect to cost-recovery in several Asian countries are as follows:

Table 2.1 Fee collection ratio of different countries

Fee collection by WUAs in %	Place
65%	Philippine
70%	Andhra Pradesh (India)
50%	Nepal
79%	Indonesia
68% - 100%	Pakistan

(Source:Easter, 1999)

There are many indicators used to compare irrigation system efficiencies. These indicators are divided into crop output based measures and system characteristics.

2.5 Sustainable supervision for irrigation systems

All development is going on process by considering human benefits and their interest, so they can spent their lives in the better ways in the present as well as in the future. The Sustainability can be manage of irrigation by observing different questions i.e. how much time it can be benefit to the people in all aspects socially, economically preserving the environment. For the irrigation system to run for a long time it needs significant financial contributions (either internally or externally; Malano & van Hofwegen, 2006). Many scientists and researcher have focused on sustainability in term of their profession and scope. Social scientists focuses that sustainable irrigation system should be accepted by all people and all should be considered. Politian focuses on institutions and governance. Engineers focused that the operation, maintenance and testing for irrigation system should be proper designed consider all parameters like infrastructure. Soil and water researchers focus on sustained fertile soil properties that are helpful for more production as well as water quality that is the key for sustainability for irrigation. The idea of Economists is that investment should be return as soon as possible.

Abernethy (1994) considers these attributes as objects of sustaining irrigation systems: irrigation facilities, production potential, operational performance, and irrigated agriculture. There is nothing to be seen correct objectives considering all. These facilities are not enough for sustaining irrigation systems, unless people do not try them. Irrigation systems are not found in the isolation form but these are not the part of different huge systems i.e. ecological system, development system, national food production etc. So there should be objective for irrigation sustainability that should have any objective in which it is established and proposed. The main purpose can be sustainability of efficiency, productivity and financial sustainability and the infrastructure of irrigation system etc. As of MAF (1997), if agriculture is to be a sustainable industry, farmers must be able to make a net profit over the long term, the scheme organization must provide sustainable and adapted services to farmers, and the resources on which farming depends must be used in a sustainable manner. To get long-term benefits requires, improving or maintaining resources, fulfill the legislative conditions with respect to environment and adjusting to international and locally market requirement.

Farmers should be trained according to the sustainable manner for the future maintenance and visibility. Farmers should be informed that they are taking better decision and they have know how of all decision i.e. what will happened after taking this decision. Irrigation

is done by farmers and main purpose is to increase their benefit and also preserves the natural resources having minimum impact on others.

Some scientists are considering land for sustainable agriculture systems, producers think about the management of resources to increase the productivity without affecting the land resources. Although the debate in the definition and measurement of sustainability is in itself a long standing continuum (Dumanski et al, 1998) there is some consensus that the major dimensions of sustainability, physical, biological, economical and social must be integrated in some still undefined way to assess progress towards this goal. Sustainability imitates a system for irrigation of water management i.e. applies different types of elements that are co-related and interact within the fashion; moreover sustainability by its nature implies a dynamic system, whose status is determined by a balance of opposing forces or trends (Svendsen, 1987).

Many scientists believe that irrigation management depends upon different factors of socio-technical activity. But Uphoff et al. (1991) insightfully point out that focusing on irrigation management should not be considered only as a socio-technical enterprise but also as an organizational-managerial one. Pavlov (2004) pointed out that good management of irrigation schemes is becoming increasingly recognized as an essential means to achieve successful irrigated agriculture. This describes that deprived performance is not end result of technical performance for operation and design of the irrigation system but sometime it become an important aspect, but different aspects based on the flaw within the institution and management. The degree to which irrigation management in Asia is sustainable in future will depend on how effective water users, policy makers, technical experts, researchers, NGOs and other stakeholder are, in designing future irrigation institutions that would cope with future complexities (Shivakoti et al, 2005).

In the history two periods (Colonial Era 1850-1945, Cold War Era 1946-1989) was focused on the poverty mitigation and food protection and on the other hand to get more profit and revenue that was regularly contradictory objectives. Now a day with the help of food protection at the national stage the schema has become wider for the improvement of livelihoods, poverty mitigation and environmental defense. In the new era of globalization (Coward, 1990), faced with budget constraints, governments have been reluctant to provide the resources needed to maintain the huge investment in surface irrigation systems. Different programs have been designed to support local farmer institutions for the betterment of management role as well as financial role in operation and preservation having limited resources. There has been a serious lag in the development of appropriate institutions to deal with the new environment of increased demand and competition for water (Barker et al, 2004).

2.6 Agency's Role in irrigation management

Three parties are mostly involved in irrigation systems: policy makers at national level, agency of irrigation system, and the direct beneficiaries (farmers) agency related to the policy making spend public capital in irrigation schemes aiming to maximize and stabilize the production by allocating feasible cost at national level. The agency of irrigation scheme prioritizes to reduce the cost of agency to make sure economic safety sustainability and its influence. Farmers value sufficient and consistent water distribution to make the possibilities of maximizing the productivity with minimum input to increase the profit at family level (Uphoff et al., 1985). Paudel, 1990 carried out a study in Nepal has concluded

that the decentralization policy had useful effects on the participation of local communities in various development sectors.

Adhikari (1987) found out in comparative study carried out in mid hills of Nepal that it is useful to give the responsibilities of small and medium scale projects which are managed by agency to the users with possibilities of technical and financial support.

2.7 Contextual variables of irrigation system

Irrigation system involves many interrelated components such as techno-ecological, Socio-political, agro-economical and functional and structural (Fig.2.1). Physical structures of the system are located in different geographical areas. Its runs in socio-political conditions with the assistance of typical agro-economic setup and constituted by socio-structural variable. All and some of components may have effects on the management of irrigation system. Before assigning the management responsibilities of an irrigation system it is needed to analyze all the components involved to see either the system can be adjusted according to the management model (Pyakuryal, 1989).

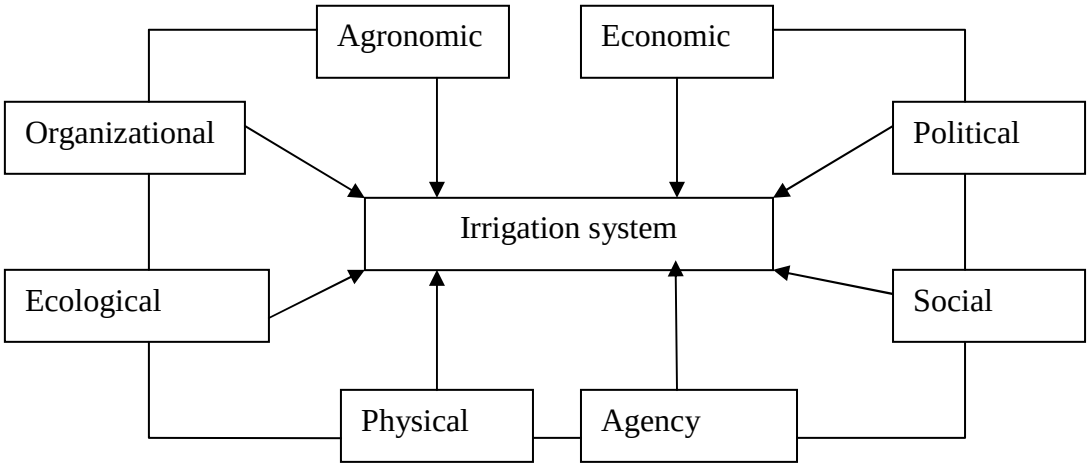


Figure 2.1 Contextual variables of irrigation system (Pyakuryal, 1989)

Many people were looking the development activities very passively in the past years which were indicated as lack of interest but the real problem sorted out was the lack of participation among stockholders in different stages. Considering lack of occasion and options of involvement of people, participation was highlighted as formation of chances to help local communities and societies to have active contribution in the development issues (Midgley, 1986).

The level and vision of participation in different types of developments issues encompass three main features relevant to participation: a) the feature of opportunity, b) the factor of capability and c) the utility feature. The first one is referred to the participation's scope, the second one deal with skills and capacity of communities. Similarly the last one is

connections with the benefits. There is the possibility for the communities to be briefed by other member of the community in case limited opportunities (Paudel, 1990). To identify the factors effecting the level and vision of communities' participation in operation and maintenance of irrigation system the following suggestions are provided by this study.

- Communities will be highly willing to participate if they think that they can get some advantages directly in operation and maintenance of irrigation system due to their involvement and contribution.
- If communities have important role during decision making process related the operation and maintenance of irrigation system will effect the mobilization of their resources.
- There will be great participation of people if they were involve in same activities in previously.
- People's participation is dependent on the level of skills and their interest.
- Community's interest and capacity to participate in operational and maintenance activities are different.
- The degree of participation of community differs with the type of activity.
- Communities more satisfaction on the equal distribution of cost and profits will keep aside greater participation.

The system stages economical performance is also an important part of sustainability in irrigation scheme. Economically self supported, ration of maintenance budge, performance of fee collection and personal cost are commonly used financial performance at the level of a system (Nelson, 2007). The income from water user's fee and other small incomes excluding the subsidies are making the financial self sufficiency ratio to the total expenditures in a year. Fee collection performance is ratio of sum of all money gained from the assessed water charges in a year. These all ration should be not very different form one. The ration of average expenditure for maintenance in one year to the average expenditures for operation and maintenance is called maintenance budge ratio. This ratio helps to find out whether maintenance should be neglected. The optimum value is different in different regions, but it equal to 50% in USA for a system having more than 30 years age but not many pipelines. It was found about 16% for a system by Ijir and Burton during 1998 in Nigeria (Nelson, 2007). The personal cost ratio is referred to the total personal cost in a year to the sum of expenditure in that year. For monitoring expenditure on personnel the personal cost expenditure is used which is usually higher compare to the other costs. Around 50% to 60% is considered the optimum level.

Conceptual Framework

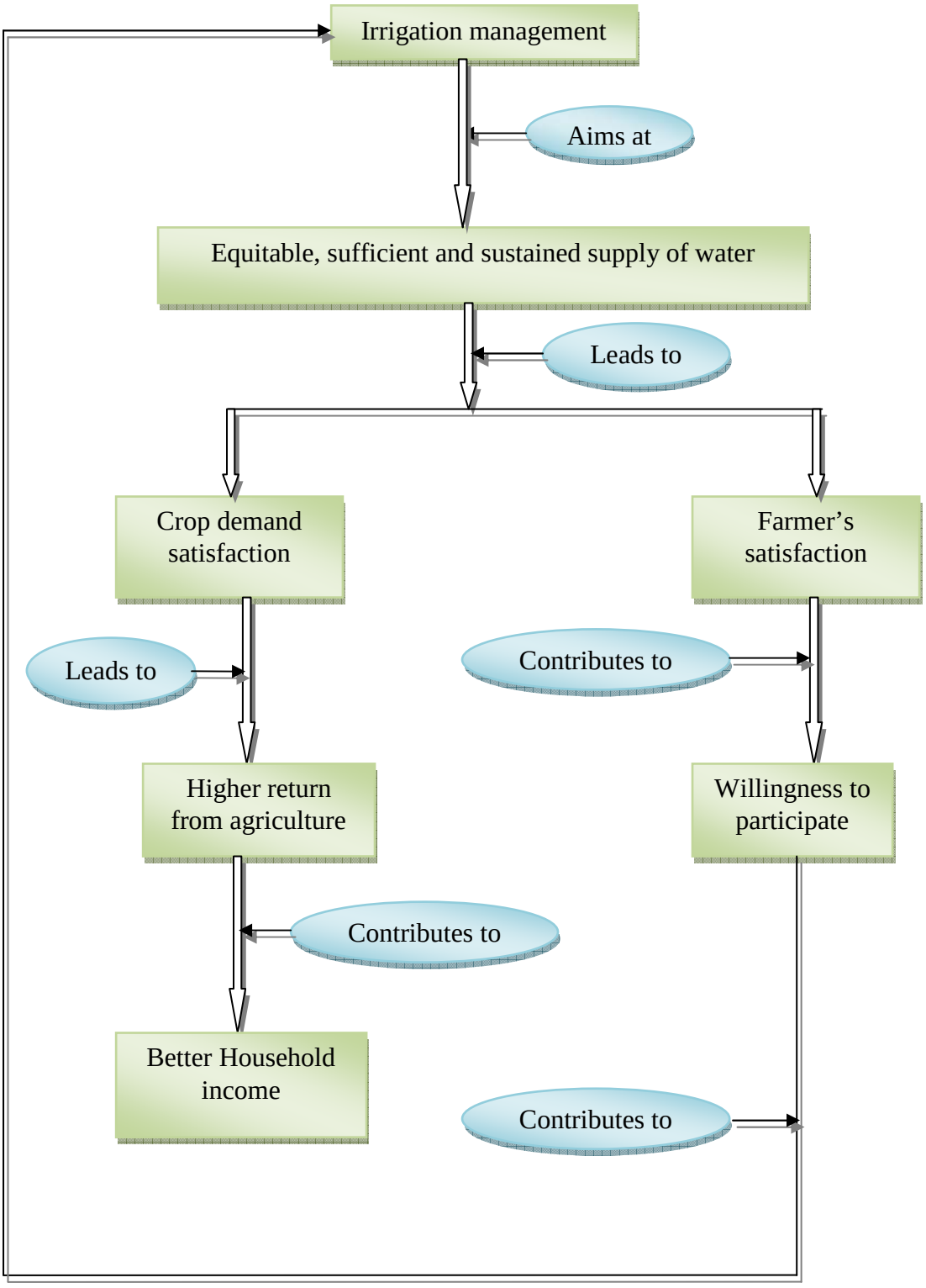


Figure 2.2 Conceptual framework

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

This chapter explains the research design of this study which directs that how to proceed this study to achieve the targeted objectives. The methodology of the study was design in such away which includes the data collection, organization, analysis and finally presentation of outcomes. To simplify the analysis process systematical approach has been selected for presenting the study.

3.1 Research design

The information was collected to achieve the objectives; data gathering has been conducted using the structured questionnaire. The study needs the sets of data from both primary and secondary sources. Different techniques including household's surveys were conducted for generating the data. Farm size of the farmers, location of the land holdings and type of farmers was considered the main focused area, as it shows differences during analysis. The location is a major factor influencing the irrigation performance. Farmers at heat region receiving more water on regular basis was privileged comparing to the farmers living at the tail regions means the farmers at the tail end are facing scarcity of water for irrigating their fields.

The descriptive and exploratory type requires quantitative and qualitative data of research will suit better while consider the topic under study. The research conduct combines both survey design and case study. The qualitative information regarding the water users groups were gathered by case study. The households' survey provided the information on control and accessibility, decision taking process and farmer's participation from the farmers using structure interviews. As this is an exploratory type of research with needed quantitative and qualitative information from both primary and secondary sources.

The sets of data and information collected from the primary sources of data, survey research method, and observation of participants were based for this study. The documents relevant to management and development were reviewed for collection of information. Further more information regarding various aspects of operation and maintenance such as costs, resources and the allocation of resources issues relevant to operation as well as management was collected from various documents and different agencies involved in related activities. The agenda and minutes of various meetings, observations, group discussion, and farmers' surveys were used to generate the data. The checklist provided was used to accelerate the interview with key informants and households surveys. Key informants and farmers household were considered the major sources of information. The government agencies, committees on village bases, regional and district offices were also included to collect the secondary data.

3.2 Pre survey field visit

Before starting the household survey the research area was visited. For assurance of quality and quantity information regarding the participation of various agencies in management of irrigation system, importance of water users association in management related issues meetings was conducted with district officers. For more information local leaders, authorities, and farmers at village levels were secreted to discuss related issues. Over all

information regarding the farm cultivation practices and type of dominant crops and irrigation systems were collected. The pre-assessment and meetings contributed positively to make connectivity with local farmers.

The designed questionnaire prepared for the household survey was pre-tested in field visits. The pre-field visits were productive in terms of to get familiar with the location of the study area. The company of enumerators during visiting the secondary and tertiary parts canals and study area greatly helped to know in detail about different issues, the friendly discussion with water user association's staff had good outputs. It was interesting while working with all people on management issues of their farm particularly the management of irrigation in the study area.

3.3 Sampling design and procedure

3.3.1 Sampling procedure

This research could be very successful if it could be conducted for the entire area under the coverage of Babai irrigation system. Due to financial constrains and time limitation this research was carried out for part of Babai irrigation system which is located on the right side of the irrigation project and ideal representative of the farmer-managed irrigation system. The selection of the research area is based on the access of farm area the network of irrigation system and irrigation management issues. The water user association in the research area was evaluated in order to select suitable water user association which represents the irrigation issues in better way.

The study area was selected using the purposive sampling procedure. Based on the factors having direct impacts on the performance the system's management, specially related to the allocation and distribution of water, construction and design of physical part, conflict solution, mobilization of resources and supplementary irrigation scheme at various regions of the irrigation system. For better exploration of performance of WUAs in management of irrigation system, it was important to select the area in such manner. The entire research area is consisted of many villages located in three different reaches of the system. All those villages located at the head, middle and tail reaches were represented by members of water user association have been selected in the sampling procedure.

The main attention of this study is given to the water user groups selected from Dhodari canal. During the selection process all ethnic groups, economic and gender groups involved in various activities of WUG while representing the executive committee was given consideration. The groups with more involvement of women diverse ethnicity and economic groups were selected. According to the households' participation in the irrigation scheme were chosen for survey. The required numbers of family were selected from the water users groups. The households were selected by using random sampling procedure.

3.3.2 Determination of the sample size

The study tried to have coverage of different types of households earning their income from different sources. However, most of households were found reliable on agriculture farming in earning their incomes having access to same quantity and sources of water in the irrigation system. The sample units representing household were selected on the basis

of different reaches (head, middle and tail). The formula given below was used for calculating the household for survey presented by Kothari, (1990).

$$n = \frac{N \times p \times q \times z^2}{e^2 (N-1) + p \times q \times z^2}$$

Where, n = required sample size
N = Population size of the households
p = Sample proportion
q = 1-p
z = Tabulated value corresponding to given confidence level
e = Acceptable error

The total estimated households of Babai irrigation project located in Bardiya are around 1300. The value assigned for p was 0.5 with further result in maximum size of sample which was computed as the most conservative sample size. The value for error was taken plus minus 8%. The level of confidence was considered to be 95%. The 134 samples were computed. And all 134 households were randomly selected for interview.

3.4 Key informants

The famer's views regarding the users managed irrigations scheme is more useful because the farmers' contribution in irrigation performance issues and farm productivity is affecting directly. As the core objective of this study is to deal with the evaluation and to identify motives, limitations, opportunities for participation of farmers in management of irrigation system, along with useful suggestions and recommendations to improve the efficiency of irrigation system managed by farmers. The farmers' participation is considered significant to enable the farmers to increase production by improving their farming system. The main objective of the research is to find facts, therefore water users' associations' management and progressive users were mainly focused.

In rural areas the local leader have key role in all aspects of life. Their ideas are very important because these leaders are directly involved in many issues regarding the irrigation system. They have long experience about all aspects of lives and farming system in the rural areas. The local leaders selected formally or informally, highly educated individuals, senior governmental and non-governmental officers, people have more experience and knowledge regarding the irrigation and respected personalities in the society were selected to be the key informant during this study. It is important to mention that local people have knowledge of traditionally used techniques. The local authorities especially officers engaged with irrigation related agencies and other relevant officers were also considered to be the key informants during the study.

3.5 Data sources and collection methods

To fulfill the objectives of the study required qualitative as well as quantitative data was collected from primary sources and secondary sources.

3.5.1 Primary data Collection

During primary data collection process the key informants were included at both user groups and households level. The household survey, interview with key informants, discussion with different types of farmers was conducted to collect the primary data. The data was collected from September to December of 2008; the field observations were also contributed to collect the primary data.

For collection of primary data structured questionnaire was used from selected households in the study area. Additional information regarding the O&M issues of irrigation scheme, information on collection and mobilization issues was collected during discussion with water user association personnel and review of useful records of WUAs. Besides, that field observation was an integral part of information collection which was done throughout field work.

3.5.2 Collection of secondary data

The collection of secondary information was collected from Department of irrigation, district irrigation offices, Babai irrigation office, and other relevant government and non-government agencies. Information regarding different policies, strategies, guidelines and plans prepared for the maintenance and management of irrigation system in the country was collected during various meetings with various agencies. Related publication and relevant documents were reviewed. Furthermore, minutes of various meetings, by-laws and rules and regulations were reviewed. Related publication and literature from various journals, books and different reports were also reviewed for secondary data collection.

3.6 Stages of data collection

There are four basic stages of primary data collection. Apart from that information collected during the field observation made a good contribution to the overall information regarding the study objectives.

Stage I: Key informant interview

This stage of primary data collection is an integral part of this research study. During this stage the two main groups of key informants were involved. The first category of key informants includes the implementer of irrigation policies at district level (Officer of DIO). This group of key informants provided useful information regarding irrigation policies, water user list of existing water users association and relevant information at district level. This stage of information was also useful for data collection in the next stages. The other category of key informant included in this stage was official of water users associations such as president, treasurer and secretary etc. The officials of water users association provide information on various related issues such as by-laws and rules and regulation of water users association.

Stage II: Focus group discussion

Stage of the primary data collection was consisted of various discussions with focused groups on irrigation water user's level. Irrigation water users have been chosen for further discussion after interviews conducted with the key informants. This discussion was carried

out with 10-15 persons including leaders of various communities, and officials of water users association including executive members. The main purpose of this stage was to collect information regarding accessibility and control on irrigation scheme, organizational setup, participation process, various meetings, situation of irrigation water, decision making process and rules and regulation. The discussion was accelerated and facilitated by using the check list.

Stage III: In-depth interview

This stage of primary data includes in-depth interview conducted with the water users, male and female members of executive body of water user association. This stage provided qualitative based changes concentrated on participation and sharing of benefits. The in-depth interview was continued by using oral history method during this stage the informants were questioned to express their views on changes in the pattern of service charges, changes in the mechanism and participation process and etc. chick list was used to facilitate the process of the interview.

Stage IV: Household survey

The above mentioned three stages were mainly concentrating on collection of qualitative information from key informants and identified groups. This stage of primary data collection concentrates mainly on collection of qualitative data from the sample farmers at household level. Within this stage the collected information was gathered form a wide range of members. This stage was carried out to collect the information from the sample farmers of all population of the study area.

3.7 Data processing and analysis

The statistical package for social science (SPSS) was used for analysis of the data. The primary data was organized in different groups and further sorted in various categories. Majority of the data sets were sorted based on various locations which were analyzed accordingly. Based on the study's objectives, the presentation of data is consisted of cross and compound tables, diagrams and charts provided in different sections. Descriptive statistics manly frequencies, means, were calculated as a requirement of this study. Important Statistical parametric and non parametric tests applied on the data to examine relationship among different variables in different locations. The Likert type scaling techniques was used to analyze response of farmers collected on irrigation issues to identify underling variable and affecting factors the major component was used. Similarly, Weighted Average Index (WAI) has been developed and used for various objectives of this research study.

3.7.1 Quantitative analysis

As the nature of the study requires quantitative analysis and qualitative analysis, for quantitative analysis disruptive statistics mainly mean, median, frequencies, percentages, standard deviation and sum were computed. For testing the relationships among various variables, Chi-square test, F-test and Kruskal wallis (h-test) were applied. To identifying underlying variables as well as factors which express the consequence of correlation in a group of data of observed indicator principle component analysis was carried out. Principle

component analysis has been also used for reduction of data to specify minor factors which express majority of variance seen in huge number of arranged variables.

For quantitative analysis purposes analytical and descriptive have been used, Statistical Package for Social Sciences (SPSS) was used for analysis of information gathered in the field. The variables having absolute numerical values such as yield per area of land, income from a specific area, etc was mostly analyzed quantitatively. The variable having qualitative values as well as numerical values was necessary to be analyzed quantitatively as well as qualitatively.

3.7.2 Qualitative data

The information for qualitative analysis has been collected from sampled households during group discussions, open-ended question, friendly and formal discussion, and field observations. Some aspects regarding the socio-economical conditions shown in analysis have based on qualitative data. It is essential to know how the users participate in collective decision, agreements, farmers perceptions, level of satisfaction in different activities related to implementations. The filed observation transparently details various phenomena concerned with our goal. All relevant factors have closely linked to come up in a detailed conclusion.

Selection of various qualitative indicators were to be considered as medium for collection of data have been based mainly on qualitative knowledge compared with prevailing situation were formatted to develop effective indicators. Case study of Water users association on present institutional organization and condition of participation regarding management of irrigation (ethnic groups, gender and economic aspects) has been analyzed and documented. The scope and limitation section of the study also viewed that qualitative analysis more weighted based on information.

3.7.3 Weighted Average Index

Different indices were calculated between 0-1 to transfer the raw data because there was difference in the units of variables. For useful measurement of the data it is important to calculate indices to get absolute, relative composite and single values. Absolute values for level of satisfaction from the structure, services, resources adequacy, efficiency of different process and structure were assessed in weightage indices. The indices were computed by multiply the weightage given to a specific response of attribute with the frequencies. There are four groups which represents different ranges ranking from highest rank of response to lowest rank of response regarding any attribute. These groups were categorized based on the indices of all responses.

The categories of different responses are evenly distributed of various ranges. The weighted given for complete response was considered to be 1.0 whereas the weighted assigned to next categorized regarding responses were considered to be 0.7 and 0.4 for middle rank because of lowering the importance but 0.1 for response which is imperfect. The intensity of responses based on their subject is summarized in Likert-type scales. The collected response which shows the agreement or disagreement regarding any subject is created by using these. The calculation of index is shown below.

$$LI = [X1 (W1) + X2 (W2) + X3 (W3) + X4 (W4)] / N$$

Where,

LI= Index for Likert –type scale
X1= Number of responses in the first category
X2= Number of response in the secondary category
X3= Number of responses in the third category
X4= Number of responses in the fourth category
N = Total number of responses
W1= Weightage for the first category
W2= Weightage for the first category
W3= Weightage for the first category
W4= Weightage for the first category

3.8 Identification of variables

The major variable investigated in this study regarding the farmers' population includes location of respondents in area under coverage of irrigation system, nature of occupation of respondents and land holding size of the farmers. Based on the allocation and distribution of water in the area under coverage of irrigation system is divided into three regions i.e. head, middle and tail reaches. The head reach is located closer to the sources of water whereas the tail reaches is located at long distance from the source of water. The middle reach is located between head and tail reaches. In fact farmers themselves had long back classified the command area in to three divisions which corresponded to the head, middle and tail ends of the system.

Location of land holdings:	Head reach
	Middle reach
	Tail reach
Farmer typology:	Full time - subsistence farmer
	Part time - regular salaried
	Part time - own business
	Full time – retired
Land holding status:	Less than 0.5 hectare
	0.51 hectare to 1.0 hectare
	1.01 hectare to 2.5 hectare
	Larger than 2.5 hectare

CHAPTER 4

STUDY AREA PROFILE AND SOCIO-ECONOMIC SITUATION

4.1 Descriptive information on study area

The study area Babai Irrigation Project is located in Bardiya district at the west of Nepal, between 28°04′ and 28°30′ north latitude and 81°15′ and 81°32′ east longitude. The main canal is moving nearly parallel to the highway at east west, the southern boundary of the study area is the boundary line between India and Nepal. There are two rivers the Man khola running at the east and other one Orai Khola which situated at the west. The Babai River is main source of irrigation of the study area. The total catchment area is around 3270 square kilometers with an average discharge of 72 cubic meter per second (Shivakoti and Bastakoti, 2007). There are five farmer managed irrigation systems formed by local communities before many years ago. Three FMIS called Raj, Mazra and Budhan kulo are located at left side of Babai River. The other two Dhodari and Jhamti kulo are located at the right side of the river. This study encompasses the Dhodari kulo farmer managed irrigation system located at the right bank. The development of Babai area not only facilitated original residents of the area but also created the settlement opportunities for many people migrated from hills to plane areas.

This study is mainly focused on irrigation strategy of Dhodari kulo at the right bank area comprised of 2666 ha. In past, there were separate diversions for supply of required amount of water in monsoon season where the quantity of water is normally greater in the main river for feeding all canals. In dry seasons usually with less quantity of water in the main river the water is allocated based on agreement between both famer managed systems located at right and left bank of the river. A weir cum bridge along with first five kilometers of main canal across national highway was constructed 1992 by the government. In order to continue the water management system in each farmer managed irrigation system, a head of each canal has been appointed to be member of the water users association (WUA) committee. The setup is totally well-matched to socio-institutional context of study area. The present study aims to assess the priority to factors and impacts of participation in the operation and maintenance of irrigation system.

The area is relatively flat, crossed by numerous streams and gullies and close to the India – Nepal border. Road access to the project area is particularly difficult in the monsoon season. Route with in the area largely consists of badly rutted cart tracks, which are impossible during the monsoon season, and cause villages to be isolated for long period of time. The mid and far western regions are relatively undeveloped compared to other regions in Nepal. The Babai irrigation project is an important boost to economic development in the mid and far western regions. These regions have a good potential for agricultural development, especially through irrigation, because of the availability of abundant water resources, and soils suitable for sustained irrigated agriculture. The mid and far western regions are relatively undeveloped compared to other regions in Nepal. These regions have a good potential for agricultural development, especially through irrigation, because of the availability of abundant water resources, and soils suitable for sustained irrigated agriculture. However, the production potential can not achieved unless modern irrigation distribution systems, which supply water in a reliable with equitable manner, are constructed.

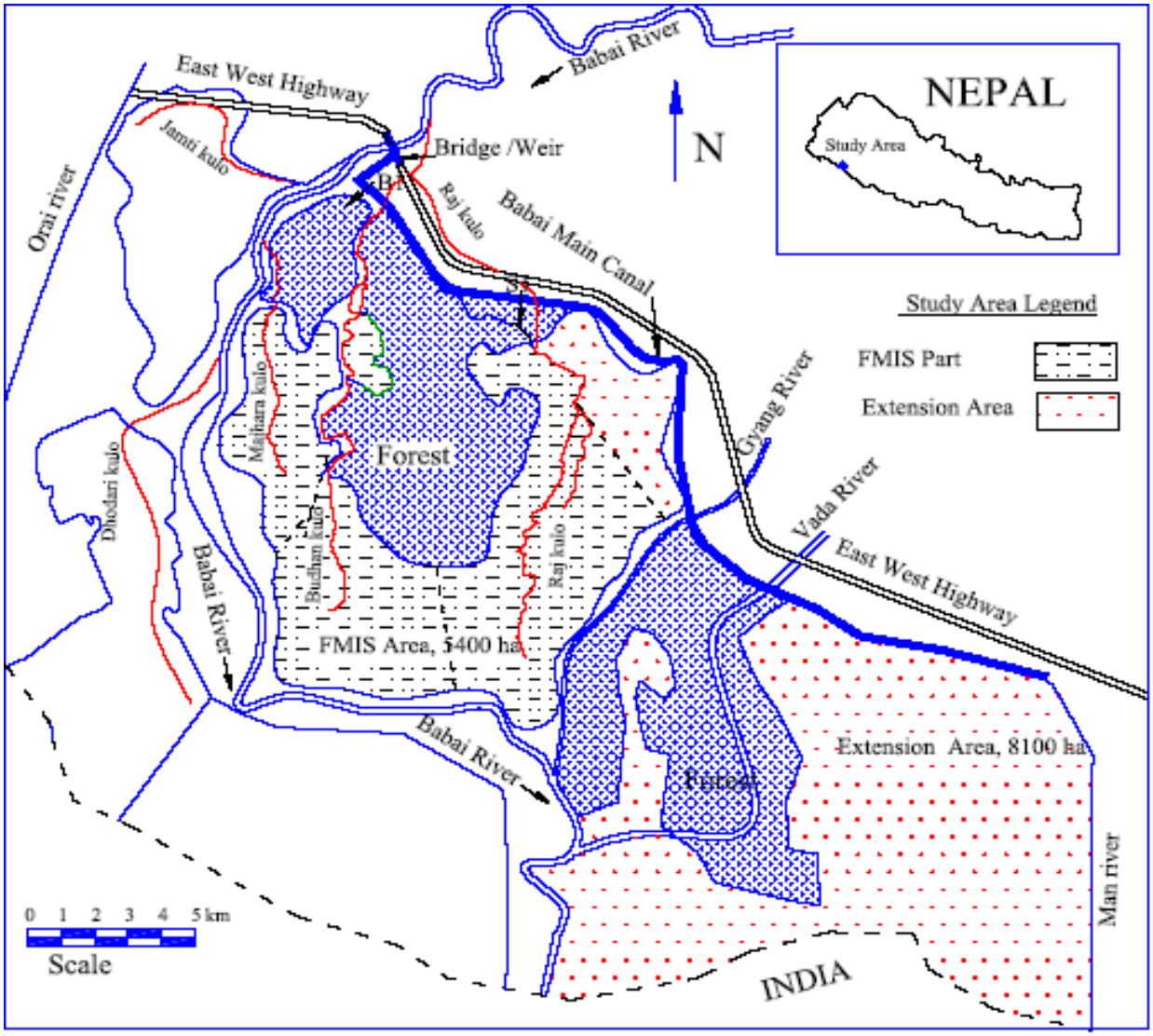


Figure: 4.1 the map of the study area showing the Babai River, headwork and main canal

Figure: 4.2 the weir cum bridge across the river

4.1.1 Climate

The terai plane has a subtropical monsoon-type climate with distinct wet and dry seasons. The summer monsoon arising over the Bay of Bengal brings rain to the terai from June to October. In the dry season, the north-east monsoon brings drier and cooler air to the terai with occasional precipitation sometime in the form of hail and thunderstorms. The highest daily temperature occurs in May and June reaching 40 degrees centigrade and occasionally higher. The lowest daily temperature of approximately 16 degree centigrade occurs in December and January. Relative humidity is lowest in April and May rising to in excess of 80% during July, August and September.

4.1.2 Soils, Topography

The area is fairly flat with elevation ranging from 170 m in the northwest to 143 m (MSL) in the southeast. The area slopes from the northwest to the southeast the average gradient being a meter to a kilometer, through the gradient is a bit steeper in the northwest. The area is crossed by a number of local streams, gullies and irrigation channels and is partly covered by deciduous forest. The soils are alluvial and fall into two main types: yellowish, grey brown soils and deep alluvial soils. Both types of soils are moderately acid to slightly alkaline, generally low in organic matter content and fertility.

4.1.3 Groundwater

Groundwater resources most relevant to the study area are those found in the auriferous strata of the older and younger alluvium; about 30% of the study area overlies aquifers strata. The sub-aquifer complex, which has a thickness of about 20 m below ground surface, is recharged through the bhabar sediments, which are replenished chiefly by rainfall and surface runoff. These sediments serve as a kind of sponge forming an operative sponge which recharges mainly in the monsoon season and draining slowly southward in to sub-aquifers. The hydrological regime of the area appears in a state of equilibrium, the sub-aquifer being recharged through seepages, rainfall and runoff, while they discharge through evapotranspiration, exploitation through shallow wells, and outflow to river beds and depression during the dry season.

4.1.4 Hydrology

The principal source of water for the irrigation is the Babai River. The river flows east to west through the dang valley and from the confluence of the tributaries for about 60 km in a deep gorge, after which a fault zone causes it to flow southwards in to the terai. Here the river broadens out and due to the change in gradient becomes unable to carry its sediment loads. The river enters India where it discharges in to the Karnali River. The dry season flows in the Babai River which does cross the India-Nepal border originate largely return flows from drainage and to a lesser extent from ground water. This babai irrigation has no significant effect on the dry and wet season river flows crossing the Nepal India border.

4.2 Existing physical infrastructure

4.2.1 Weir

The diversion structure ,to be located on the babai river about 5 km upstream of Bargadaha, is comprise of a concrete weir with scour sluices on the left bank and the canal intake located on the outside of a curved sluiceway which is set downstream of the axis of the weir and separated from it by a fish ladder. The scour sluices is consist of three 10*4 m gates. A curved sluiceway is used to overcome the tendency in straight sluiceways to form deposits at the divide wall adjacent to the weir. The overall width between left and right bank abutments at the approach to the weir is 270m. The weir supports a road bridge which is allowing the east-west highway to cross the Babai River.

4.2.2 Headwork

The headwall for the intake is located adjacent to the scour sluices. Tapering intake tunnels is provided to five 2.5 m span intake gates .The design capacity of the intake related to upstream water level at weir crest level is 53m3/sec. A settling basin, approximately 1 km long, is located downstream of the canal intake and is terminate in a dividing structure comprising a crump weir and flushing sluices. The settling basin is line to resist erosion. Its layout is largely determined by the river configuration and the head required flushing the sediment back into the river. The maximum flow which is let in to the basin is estimated at 63 m3/sec based on the upstream water level corresponding to a river flow of 250 m3/sec. The basin is capable of operating on an intermittent or continuous basis. Operation on an intermittent basis is only takes place if river flows are too low to operate the basin on a continuous ejection basis. The sluices for flushing the sediments from the settling basin would consist of five tunnels with 2.5 m span gates located at their downstream end. The tunnel is passing under a crump weir. Canal supply is pass over the crump weir, which could be used to measure the discharge in to the main canal , and the sluicing flows pass through the gated tunnels, allowing the sediment in the settling basin to be sluiced back to the river. For continuous operation the gates would be partly opened which would allow flow back in to the river.

4.2.3 Main canal

From the setting basin the water flows in to a 28 km long main canal. The main canal runs parallel to the east west highway within a confined easement of 100 to 150 m. The capacity at the head regulator of the main canal is 18.40 cumec which would allow for enlargement of irrigation facilities at full development on the left bank 19000 ha. All main canal reaches would be sized for full development, except for sections in heavy cut. On about 25% or 7 km of the main canal length concrete lining would be adopted. These portions require lining because soils are permeable and land slopes steep. Gross regulators and cross drainage provisions would be planned at approximately 3 and 0.5 km intervals respectively. The regulators, which in most cases would be combined with drop structures, would be provided with fixed crests and sliding lifting gates to control the supply levels.

4.2.4 Branch, Secondary and Tertiary canal systems

The area to be irrigated is gently undulating. The ridges of the undulation would from the canal lines. From the main canal the water would be diverted in to branch and secondary

canals and from these in to tertiary canals. The Babai irrigation area is subdivided in to blocks mainly to facilitate the block wise development of irrigation facilities as the work on the main canal system progresses from its head towards the tail. All together 29km of branch canals, 169 km of secondary canals and 400 km of tertiary canals is constructed. The tertiary canals are constructed by mobilizing farmer's participation in accordance with the irrigation policy of the government.

4.3 Socio-economic situation

The total population of the study area is around 1300 households. About 54 percent of total population is male while 46 percent is female with the average age of 51 years old. The average family size in household is equal to nearly 7 people. The average farm size of owner land is 1.65 ha where the average farm size cultivated by farmers was found about 2.45 ha. The main crops cultivated in the area are paddy, wheat, maize, mustard, pulses and potato but the major dominant one is summer paddy. The cropping calendar for major crops is June, July to October.

There are few local markets located in adjacent areas of Babai irrigation system. These local markets are the only easily accessible places in the area where all farmers sale their agriculture products and buy other expendable and non expendable goods for their household requirements. There are whole seller and stock buyers as well as retailers in the local markets but the buying prices of agriculture goods from the farmers are relatively lower compare to the main markets in the downtown. Though the buying rates in the local markets are lower than the main markets in the city but the farmers are willing to deals in the local market because of transportation cost and time constraints. The farmers living in the area are also buying seeds and other agriculture inputs such as fertilizers, pesticides and other agricultural equipments.

Table 4.1: Descriptive information about BIS

Average age of farmers (years)	51	10.96*
Average size of family	7	2.49*
Average farm size owner land	1.65	1.44*
Average farm size cultivated by farmer	2.45	0.96*
Main crop	Summer paddy	
Crop calendar of main crop	June, July to October	
Main marketing outlet	Local market	
Existing Irrigation service fees(Rs/ha)- for main crop	120	

*= Standard deviation

Source: WUA records, Author's Field Survey, 2008

4.3.1 Occupation

In the context of income sources the farmers are not reliable on agriculture activities only there are some other sources which make a good contribution in providing the opportunities to farmers to earn their income. The main sources of income beside

agriculture are livestock rearing, fish farming, labor work, small vending and trading. The information is summarized in table 4.2 below. However, Population is engaged in different types of occupations, mainly full time farmer, and regular salaried employee, self employed and retired.

Agriculture is the major sector, engaging about nearly 69 percent of household population in the study area. People are also getting income from some other sources like regular/salaried employee, and self employed. It has been observed that 12 percent population is engaged in regular/ salaried employee in the government sector or any other company as occupation. Some people about 13 percent are involved in self employed as a part time along with agricultural farming. Only 5 percent peoples are retired and busy with their farming. Part of young generation prefers to work in abroad rather than in agriculture sector.

The female also have fairly good contribution in the total income of a household beside their assistance in the agriculture farming activities. The main contribution of female in the agriculture activities is highly visible during the plantation process, harvesting as well as weeding seasons.

Table 4.2 Main livelihoods by land occupies in Babai irrigation system

Main occupation	**Numbers of farmers**	**Percentage**
Full time farmer	93	69
Regular/ salaried Employee	16	12
Self- employed	18	13
Retired	7	5
Total	134	100

Source: Author's field survey, 2008

4.3.2 Educational status

Majority of farmers in the study area are found very low literacy rate. It is obvious that many farmers were with low education but they were equipped with good capacities and skills regarding the agriculture activities. The low literacy rate of farmers will create problems in adaptation of new agriculture technologies, active participation in many agriculture development programs and clearly understanding the objectives of certain projects. Education is considered a key factor which is directly involved and closely linked with the adaptation of modern agriculture technology and exchange of new ideas and thoughts among various stakeholders.

Education is important because it is highly recommended to demonstrating or taking trial of many new innovations in agriculture before actual adoption of the technology. Important agriculture policies which is consisted as new type of management system of irrigation is long time consuming process to be adopted but it is also dependent the level of understanding capabilities of farmers for implementations. Therefore education is considering a core requirement prior to take action on the distribution of information during the exchange of agriculture itself. Table 4.3 Shows the educational status of the

sampled population under larger farm size households was found to be better than that of the smaller farm size group. The highest educational status 43 percent of sampled household members was noticed among the population under the large farm group. The educational status of the BIS was found significant difference among all farm size, means the higher the education level, the bigger the farm size.

Table: 4.3 Educational statuses of the respondents by farm size

Farm size category	Education level				Total
	Illiterate	Primary	Secondary	Higher	
Marginal	12	7	1	2	22
	(55)	(32)	(4)	(9)	(100)
Small	8	14	6	5	33
	(24)	(43)	(18)	(15)	(100)
Medium	13	12	18	6	49
	(27)	(24)	(37)	(12)	(100)
Large	1	7	9	13	30
	(3)	(24)	(30)	(43)	(100)

Chi- square value =34.681 df =9, P=0.000

(Figure in parenthesis represents the percentage)

4.3.3 People and ethnology

The total estimated population of the study area is about 8700 located in 1300 households. Some of the households living in this area have been migatrated from the hilly areas; almost half of the population belongs to the indigenous group called as tharu. The tharu are composed of number of endogamous sub-groups those groups are used to live in compact villages with number of joint families. The socio-cultural customs have not been well documented about this area. The ethnology of the local population composed of various caste; Tharu is the most leading caste with 30 percent households, and covering 20 percent area only. Where as Brahmin and chhetri comprise 29 and 22 per cent households with 31 and 26 percent of area covered respectively. The Brahmin and Chhetri caste are including among the advantaged groups with higher cultural and ethnological values. The rest of the caste includes Tamang, Newars, Gurung etc, covering only 9 percent households with 12 percent area. Castes like tharu, Magar, Gurung and tamang are under disadvantaged groups, and also called as *"janajati"*. Dalit is the most disadvantaged and depressed caste, also known as "*untouchable caste"*. They are restricted to their some professions like stitching (tailor), blacksmith (kami), and sarki (mostly shoes maker) with 4 percent households and covering only 3 percent of the total area (Table 4.4).

Table 4.4 Land distribution by caste and farm size in BIS

Caste category	Farm size									
	Marginal		Small		Medium		Large		Over all	
	%HH	%Area	%HH	%Area	%HH	%Area	%HH	%Area	%HH	% Area
Bramhin	25	26	30	26	28	34	35	41	29	31
Chhetri	17	19	20	23	27	33	22	29	22	26
Tharu	35	18	25	28	30	18	29	16	30	20
Magar	5	9	8	9	7	9	5	3	6	8
Dalit	4	5	7	4	3	2	-	-	4	3
Others	14	23	10	10	5	4	9	11	9	12

Note: The figures represent the percent of the households in farm size groups

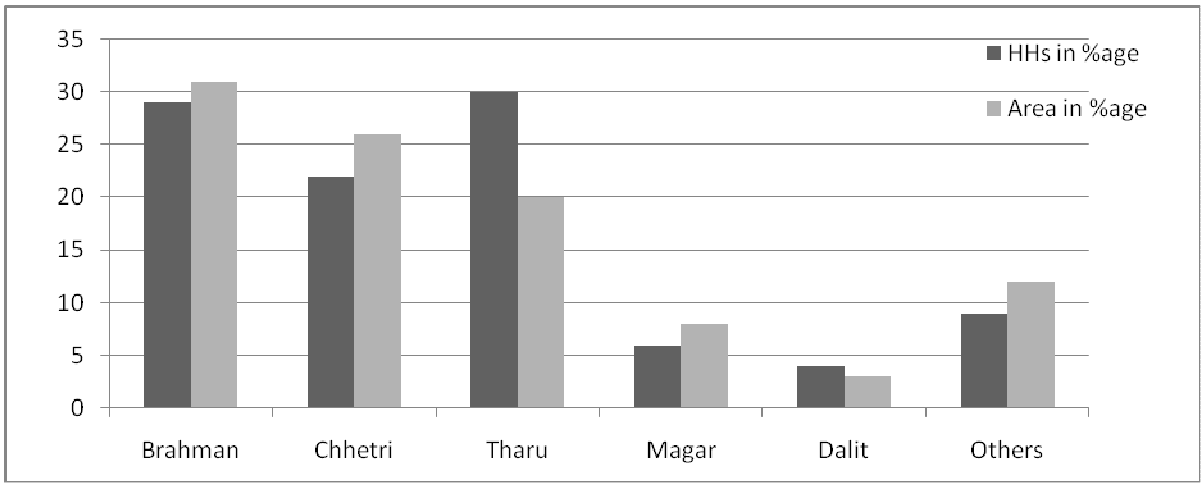


Figure: 4.3 Households and area by ethnicity

4.3.4 Land Use system

The respondents belong to the community, settled in Bardiya four and half decades before by the government. The assents behind this step to allocate farm land to the farmers were to get income and other activities for their proper livelihoods. The tenants use the land in exchange for a fixed amount of money or produce or for a combination of the two. The most common arrangement is adhiya (half) system, in which 50% of all produce from the land is payable to the landlord. It is estimated that most of the tenants fall under this system.

In the past there are traditional arrangement known locally as the “Kamaiya system”. The kamaiya system is not so much a tenancy system as a mode of payment by the bigger farmers for the labor of the “Kamaiya”, who technically is a permanent farm laborer. Later on, farmers have been used to rent-in and/or rent-out their farms in many parts of this

district. The tenancy factor had played a significant role in the farming practices for the agricultural development in the country. In order to analyze the local land use system, total area by the each household were considered as the base factor.

As the samples were selected, representing three distinct region in the system the, information are also grouped accordingly for analysis of parameters like irrigation supply, crop coverage, yield, satisfaction indices considering the fact that total production of a crop, the resource needed for cultivation and the income varies with farm size. So the relevant information was grouped on the basis of farm size. Due to the practice of share cropping the area cropped may be different from the area owned. Farmer interest with the irrigation system is associated with the irrigation facility available in the cultivated plot. To find out the land distribution pattern and the land holding per family an established land size classification was followed according to following criteria.

- Land taxation policy of the government which defines tax free farm size as that of less than or equal to 1 hectare approximately. Thus a family possessing a farm size of 1 hectare or less is said to be a small farmer.
- From an agricultural policy view point and in an agricultural, a farm of more than a hectare and up to 2.5 hectare is a medium size farm and considered a subsistence farmer
- A farm more than 2.5 hectare is relatively a large farm

The above classification has been considered useful in understanding the dependency of the farmer and productivity of land are of more practical significant grouping (FAMS, Nepal, 1982). To avoid the over concentration of particular group type characteristics in analysis the small farm was further broken down into marginal and smaller farm. So, in this study the farmer were classified in to four categories as follows.

Marginal farm	:	Less than 0.5 hectare
Small Farm	:	0.51 hectare to 1.0 hectare
Medium farm	:	1.01 hectare to 2.5 hectare
Large farm	:	Larger than 2.5 hectare

CHAPTER 5

AGRICULTURAL PRODUCTION AND ECONOMIC EFFICIENCY

The main source of livelihood of most people in study area is agriculture. Huge number of the sampled household's dependents on agriculture in term of employment. Due to change in landholding sizes, cropping pattern, agricultural inputs and modern technology have brought changes in agricultural practices. This chapter tries to attempt farmers' ownership of land holdings, tenancy type and agricultural production and economic efficiency of different major corps cultivated in the study area.

5.1 Land tenancy system

It has been found that highest number of land tenancy type is owner cum rented in which is 66 % in sampled population. It indicates that most of the farmers in the area rented out their lands to two or more than two farmer for cultivation. The total number of farmer's owner cum rented out is about 29% in the sampled households. Owner cultivated farmers in the sampled households were few in number which makes only 3 % of the total households surveyed. Some farmers were also found who have been practicing agriculture activities as mix (Owner, rented in and rented out) in the area. The sampled household constituted 2% as mix type of tenancy system. The table 5.1 summarizes the tenancy type of the sampled household.

Table 5.1 Tenancy practice by distribution of sampled households

Tenancy type	Percentage of distribution
Owner cultivated	3
Owner cum rented in	66
Owner cum rented out	29
Mix (Owner, rented in and rented out)	2

5.2 Land holding size of farmers

The total cultivated land in the area is divided into two main categories a) khet cultivated land or wet cultivated land and b) Bari cultivated land or uplands. Around 16 percent of farmer families are under the marginal farm size with an area of 18 percent of total cultivated area. Another 25 percent of the cultivated area is under the coverage of small farm size which constitutes 25 percent of total households covered in the study. The medium size farmers (which are operating 1-2.5ha) are representing to be highest group which covers an area of 32 percent to total cultivated area and makes about 37 percent of total sampled population. The large size farmers group is consisted of 22 percent of sampled households with 25 percent of total land area under cultivation in babai irrigation system. Table 5.2 below provides view of the operational land holdings size. The data indicates that some marginal and small farmers rented in land from the large farm size. The total cultivated land found in sampled household is about 328 ha where as the total mean of cultivated land is abut 2.45ha. The mean of total cultivated land under operation of

marginal, small, medium and larges farm sizes are 2.71, 2.51, 2.16, and 2.68 ha respectively.

Table 5.2 Operational land holding size and households against farm size

Farm category	cultivated area (in ha)	Mean (in ha)	HH no.	Percentage of household	Area coverage percent
Marginal (<0.5 ha)	60	2.71	22	16	18
Small (0.5 to 1.0 ha)	83	2.51	33	25	25
Medium (1.0 to 2.5 ha)	106	2.16	49	37	32
Large(More than 2.5 ha)	81	2.68	30	22	25
Total	328	2.45	134	16	100

Source: Author's field survey, 2008

Middle farmers households which are around 36 percent of total sampled population with the highest area of coverage which is about 39 percent. The head region is followed by the middle region, consisted of 34 percent households with coverage area of 32 percent cultivated area. The tail region has found with 30 percent households with cultivated area of 29 percent. Table 5.3 provides an overview of operational land holding size and number of households at different regions.

Table 5.3 Operational land holding size and households against location

Location	**Total cultivated area (ha)**	**Mean (ha)**	**HH no.**	**Percentage of HHs**	**Area coverage percentage**
Head	105	2.27	46	34	32
Middle	129	2.68	48	36	39
Tail	95	2.38	40	30	29
Total	328	2.45	134	100	100

Source: Author's field survey, 2008

5.3 Farmers typology

The typology of the farmers is recognized to identify differences in farming systems and farmers in the study area. For differentiating the famers type three major criteria were specified during the detailed interview process. These are occupation of the sampled household, farm location and farm size. The farmer's responses were recorded based on agriculture farming system in the study area. The farmers were classified in two main groups one is full time farmers and other is part time farmers.

The full time farmers are further divided into two types such as full time-subsistence farmer and fulltime-retired farmers. The part time farmers are also further divided into two types such as part time-regular salaried and part-time-own business farmers. The farming strategies of different type of farmers were diversified from each other. For analysis of agricultural performance the typology of farmers exists in the study area were used. The typology used for the analysis was further explained with different parameters such as major crop yield (production), production cost and income from agricultural production by

using Statistical Package for the Social Sciences (SPSS) to find out either each parameter is significantly different or not. The major typology of farmers is given as below.

I) Full time farmer (Type-I)
II) Part time farmer-regular salaried (Type-II)
III) Part time farmer- own business (type-III)
IV) Full time farmer- retired (Type-IV)

The table 5.4 summarizes typology of different farmers in different locations. The average of full time subsistence farmers are 69 percent in all three locations. The ratio of fulltime subsistence farmer is quite higher in the head region which is around 72 percent while in the middle and tail regions they are only 69 and 68 percent respectively. Part time farmer-Regular salaried was found with average of 12 percent. The number of this type of farmers is also greater in the head region which is 13 percent. The average of Part time farmer-Own business in head, middle and tail region is 13 percent. The average of full time farmer- Retired in all three regions is only 5 percent of all types of farmers.

Table 5.4: Number of respondents by typology and location wise

Type of farmers	**Location-wise nos of farmers**			**Average**
	Head	**Middle**	**Tail**	
Full time farmer	33	33	27	93
	(72)	(69)	(68)	(69)
Part time farmer- Regular salaried	6	5	5	16
	13	(10)	(12)	(12)
Part time farmer- Own business	5	8	5	18
	(11)	(17)	(12)	(13)
Full time farmer- Retired	2	2	3	7
	(4)	(4)	(8)	(5)
Total	46	48	40	134
	(100)	(100)	(100)	(100)

Chi-square=1.402 DF=6 P= 0.966
(Figure in parenthesis represents the percentage)

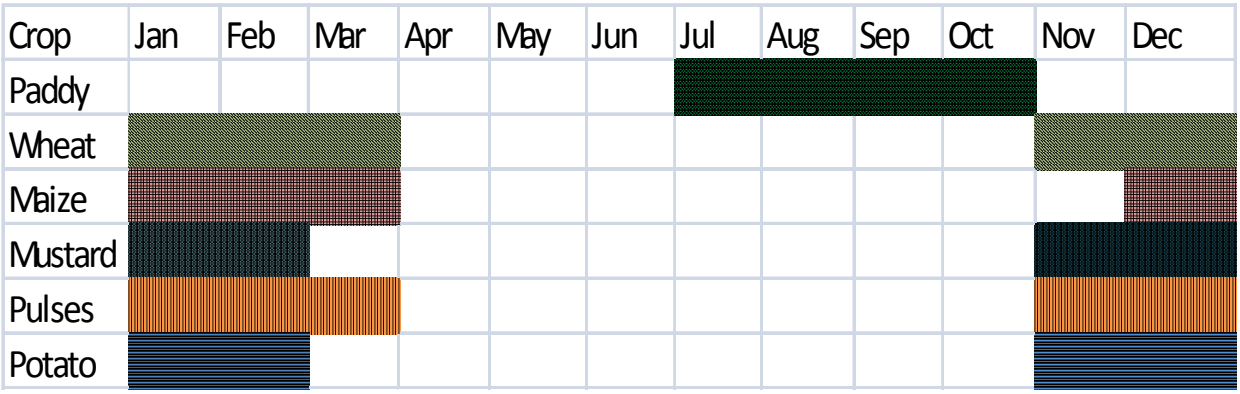
5.4 Cropping pattern, cropping intensity and crop calendar

In the Babai irrigation system, farmers are engaged in rising different agronomic and some horticultural crops. Normally, crop farming and livestock farming are experienced in the integrated form. Major agronomic crops have been growing in the area include rice, wheat and maize. Farmers are used to cultivation of crops through following some typical patterns of crops rotation as mentioned below in the cropping calendar. Paddy is the dominant crop grown in the study area. Almost all farmers grow monsoon paddy. The maize grower is found higher followed by mustard, wheat as cropping pattern also related to the availability of water.

There are mainly three season for crop cultivation: summer, winter, and spring. The main summer crop is paddy. In winter season mainly wheat, pulses, oilseeds, potato, maize and Vegetables are usually grown. In spring season major crops are maize and vegetables. Farmers are used to cultivation of crops through following some typical patterns of crops rotation as mentioned below.

Paddy	Wheat	Maize
Paddy	Mustard	Maize
Paddy	Potato	Fallow
Paddy	Fallow	Maize
Fallow	Wheat	Maize
Maize	Mustard	Fallow

The overall coverage of paddy is about 70 percent, as most of the area is found under paddy crop. There is no significant difference between different farm sizes. Maize, wheat, and mustard cultivation is found higher in case of large farm size than other farm sizes like marginal, small and medium. The trend of cropping systems has changing continuously from the traditional to commercialized agricultural cropping system. Still farmers are facing a numerous problems regarding the extension services, input availability and market services.



Source: Authors field Survey, 2008

Figure: 5.1 Crop calendars of BIS

Table 5.5 summarizes the cropping intensity in different location in the study area. The cropping intensity value at the middle region is found higher than the cropping intensity in the head and tail region of the system. The cropping intensity in middle is 186 percent which indicates that about 5 percent higher than in the head region which 181 percent in

the head. Cropping intensity in the tail region is about 179 percent which means about 2 percent lower than head and 7 percent lower than middle.

Table 5.5 Cropping intensity by location

Location	No. of Farmers	Cropping Intensity	Standard deviation
Head	46	181	36.81367
Middle	48	186	29.94325
Tail	40	179	32.20391
Total	134	182	32.98490

DF=2 f=0.516 p=0.598

Table 5.6 summarizes the cropping intensity in different farm size in the study area Cropping intensity for different farm size varies from 161 percent for marginal farms to 192 percent for large farms. Recently the farmers have shown their interest to grow potato and other cash crops in the area in winter season. Water scarcity, lack of extension service and inputs are reported to be the major reasons given by the farmers for not growing the crops as they would like to grow.

Table 5.6 Cropping intensity by farm size

Farm size	No. of Farmers	Cropping Intensity	Std. deviation
Marginal	22	161	21.20777
Small	33	176	29.17885
Medium	49	190	31.09823
Large	30	192	39.20033
Total	**134**	**182**	**32.98490**

DF=3; f=5.780; p=0.001

5.5 Crop production based on different variables

The four major types of farmers are identified which is describe in detail in above section. The diversity in cropping strategies agriculture production, gross and net income in type of farmers was assumed. Similarly the area under irrigation system was divided in to head, middle and tail regions based on the quantity of water availability. This section will examine the diversity in three different regions. The major goal of this section is to see the performance and diversity of different types of farmers. Farm sizes is also considered for finding out the differences of farming performance are significant or not. The number of respondents in farm size, location and typology of farmers are different. The statistical package for the social science (SPSS) is used for analysis of different parameters.

Table 5.7 shows the analysis carried out for the crop yield of different major crops under cultivation in the study area. It indicates that the type-I farmers harvest highest yield in paddy, wheat, maize, pulses crops cultivation. The mustard crop yield is found higher in case of type-IV farmers. The type III farmers show the highest figure of potato crop yield. It reveals that the agricultural performance were found best in type-I farmers because the

type-I farmers usually have frequent access to modern agriculture equipments. They usually allocated more time and attention to their fields. The statistical analysis indicates that the crop yield from paddy, wheat, maize and mustard crops are highly significant difference at 5% significance level where as the pulses crop yield was found significant different at 10% level of significance. Only potato crop yield was found non significant among all farmer types.

Table 5.7 Different crop production against farmer's type

Crops	**Crop yield (kg/ha)**					**ANOVA**
	Type-I	**Type-II**	**Type-III**	**Type-IV**	**Av.**	**(F-test)**
Paddy	4062	2907	3804	3930	3883	Df=3; F=26.418;P=0.000; *
Wheat	3580	2723	2197	3021	3263	Df=3; F=66.418;P=0.000; *
Maize	2272	1930	1852	1953	2158	Df=3; F=20.857;P=0.000, *
Mustard	488	364	472	491	471	Df=3; F=10.208;P=0.000; *
Pulses	586	559	529	524	572	Df=3; F=2.429;P=0.068, **
Potato	2964	3011	3092	2636	2970	Df=3; F=.843;P=0.473; ns

Source: Author's field data; 2008
Note: * = Significant at 5% significance level, ** Significant at 10% significance level, ns= non significant

Considering the coverage of the crops cultivated in the area: paddy (summer), wheat, maize, mustard, pulses and potato are the six crops considered in analysis of the overall agricultural characteristics of the system. Table 5.8 illustrates that yield of different crops for different location. The yield of paddy and Maize is found to be higher in the head region than in the middle and tail region. The reason for this is the poor soil characteristics and lower water availability in the other region of the Babai irrigation system.

Similarly the yield of wheat, mustard, pulses and potato has been observed higher in middle region than other region. The quantity of irrigation water availability at the head region is higher which results in higher yield comparing with middle and tail regions with less amount of irrigation water in the scheme.

Comparison of Paddy, and mustard between head, middle and tail of the scheme resulted that statistically there is significant different in their means at 5% significance level, where as wheat is significant difference at 10% significance level. Comparison of maize, pulses and potato crops between head, middle and tail of the scheme resulted that statistically there is no significant difference.

Table 5.8 Major crop Production in Babai irrigation system by location

Crops	Crop yield (Kg/ha)				ANOVA
	Head	Middle	Tail	Average	(F-test)
Paddy	4085	3827	3718	3883	Df=2; F=4.491; P=0.013; *
Wheat	3256	3404	3101	3263	Df=2; F2.358; P=0.099; **
Maize	2183	2155	2134	2158	Df=2; .F=281; P=0.756
Mustard	475	515	415	471	Df=2; F=16.287; P=.000;*
Pulses	556	584	575	572	Df=2; .F=916;P=0.403; ns
Potato	2980	3030	2885	2970	Df=2;F=.543; P=0.582; ns

Source: Author's field data; 2008
Note: * = Significant at 5% significance level, ** Significant at 10% significance level, ns= non significant

Table 5.9 summarizes statistical analysis of crop production based on farm sizes. Mean of each crop production with respect to the land size is computed. The data indicates that the large land holding farmers have better performance in production of paddy crops whereas, the production of maize and pulses is higher in the marginal region farmers.

It is expressed by the farmers that income from the maize and pulses cultivation is found higher in case of marginal farm size in compare with the other farm sizes. The paddy yield from the large farm size is higher. The crop yield per hectare from wheat and mustard crop is highest from the medium farm size. The paddy, wheat and maize crop yield is lowest from the small farm size. Where as, the mustard and potato crop yield is lowest in case of marginal farm size, and the yield of pulses is lowest in the large farm size. Comparison of crop yield based on the landholding resulted that there is highly significant difference in there means at 5% significance level, except potato where small holders farmers have higher productivity.

Table 5.9 Major crop production in BIS by farm size

Crops	Crop yield (Kg/ha)					ANOVA (F-test)
	Marginal	Small	Medium	Large	Average	
Paddy	4011	3596	3789	4257	3883	Df=3;F=8.196;P=0.000;*
Wheat	3010	2996	3655	3100	3263	Df=3;F=11.514;P=0.000;*
Maize	2354	2053	2128	2181	2158	Df=3;F=4.928;P=0.003;*
Mustard	397	470	503	475	471	Df=3; F=7.784;P=.000; *
Pulses	618	605	593	469	572	DF=3;F=21.196;P=0.000;*
Potato	2819	3084	2938	3008	2970	DF=3; F=.800;P=0.496; ns

Source: Author's field data; 2008
Note: * = Significant at 5% significance level, ** Significant at 10% significance level, ns= non significant

5.6 Production cost, gross income and net farm income

This section expresses the average gross income, production cost and net income of major dominant crops for each type of farmers in the sampled population with regard to the different farm size and location. Production cost for each single crop, inputs, and average prices of product were gathered from the farmers during the interview. The prices for each unit were collected from different sellers, water user association members while taking group discussion session. The gross income was computed form the available information. As agriculture is the major occupation of the people in the Babai irrigation system, so, agriculture is providing the major means of livelihoods of the local people through providing reasonable income. Some farmers have also other sources of income, but farmers prefer agriculture as the major source of income as return from agriculture as an occupation is regular and up to some extent guaranteed also. The difference in production cost of various types dependent on location and type of crops in the command area.

Table: 5.10 Gross income, production cost and net income per crop against location

Crop		Head	Middle	Tail	average	ANOVA (F-test)
Paddy	GI	51057	47839	46472	48535	Df=2;F=4.491;P=0.013*
	PC	18099	17202	17168	17500	Df=2; F=2.955;p=0.056**
	NI	32958	30636	29304	31036	Df=2;F=2.593;P=0.079**
Wheat	GI	36671	37856	34678	36500	Df=2;F=2.763;P=0.067**
	PC	14930	15527	16058	15481	Df=2;F=3.114;P=0.048*
	NI	21740	22329	18619	21020	Df=2;F= 3.281;P=0.041*
Maize	GI	24016	23703	23474	23742	Df=2; F=.281;P=0.756,ns
	PC	15000	14936	14962	14966	Df=2;.F=024;P=0.977,ns
	NI	9016	8766	8512	8776	Df=2;F=.199;P=0.820,ns
Mustard	GI	11400	12360	9948	11310	Df=2;F=16.287;P=0.000,*
	PC	9026	8538	8663	8743	Df=2;F=1.545;P=0.217,ns
	NI	2374	3823	1286	2568	Df=2;F=10.700;P=0.000,*
Pulses	GI	9571	10069	10089	9904	Df=2; F=.560;P=0.573,ns
	PC	8619	8621	8949	8718	Df=2;F=.204;P=0.815,ns
	NI	952	1448	1140	1186	Df=2;F=.523;P=0.594,ns
Potato	GI	24719	25986	25156	25303	Df=2;F=.420;P=0.658,ns
	PC	11615	11606	11910	11700	Df=2;F=.223;P=0.800,ns
	NI	13104	14379	13246	13603	Df=2;F=.436;P=0.648,ns

Table 5.10 summarizes the production cost, gross income and net income in different location of the scheme. it has been found that the gross income, production cost and net farm income of paddy and maize is the highest at the head region than the middle and tail regions. The gross income of paddy is statistically significant difference at 5% significance level where as the production cost and net income from paddy is significant difference at 10% significance level.

It has been noted that gross income and net income of wheat crop are found as highest at middle region where as production cost of wheat crop is found higher in case of tail region.

The production cost and net farm income of wheat crop has been found significant difference at 5% significance level and the gross income is significantly difference at 10% significance level among all reaches. The gross income, production cost and net income of maize crops has been found non significant difference among all regions. For the mustard crop cultivation in the study area has been found that the gross income and production cost is higher in head region whereas, gross income is statistically significant difference among all reaches but the production cost is shown non significant among the reaches. The net income is higher in middle region in the study area with significantly difference. The gross income and production cost for the pulses crop cultivation is higher for the tail region farmers whereas the net income is higher in case of middle regions with non significant difference among all reaches The potato crop cultivation in the middle region show higher gross and net income while the production cost is higher for the tail region cultivators with no significant difference in their mean (Table 5.10)

Table 5.11 Gross income, Production cost and net income of different crops by farmer type

Crops		**Type-1**	**Type-II**	**Type-III**	**Type-IV**	**Av.**	**ANOVA (F-test)**
Paddy	GI	50780	36336	47556	49125	48535	DF=3;F=26.418;P=0.000,*
	PC	17442	17854	17513	17421	17500	Df=3;F=.176;P=0.912 ,ns
	NI	33337	18482	30043	31704	31036	Df=3;F=27.515;P=0.000,*
Wheat	GI	39380	29948	28716	33234	36500	Df=3;F=39.576;P=0.000,*
	PC	15340	15308	16293	15656	15481	Df=3;F=1.061;P=0.368, ns
	NI	24040	14640	12423	17578	21020	Df=3;F= 30.45;P=0.000,*
Maize	GI	24996	21230	20374	21481	23742	Df=3;F=20.857;P=0.000,*
	PC	14970	14507	15177	15411	14966	Df=3;F=.917;P=0.435 ,ns
	NI	10026	6723	5198	6070	8776	Df=3;F=16.446;P=0.000,*
Must-ard	GI	11714	8745	11320	11794	11310	Df=3;F=10.208;P=0.000,*
	PC	8700	8888	8767	8914	8743	Df=3;F=.121;P=0.948 ,ns
	NI	3014	-143	2553	2880	2568	Df=3; F=6.715;P=0.000,*
Pulses	GI	10094	9439	9520	9437	9904	Df=3;F=.526;P=0.665 ,ns
	PC	8006	7735	7183	7650	7842	Df=3;F=.865;P=0.461 ,ns
	NI	2088	1704	2337	1787	2062	Df=3;F=.208;P=0.891 ,ns
Potato	GI	24601	26276	28542	24086	25303	Df=3;F=1.929;P=0.128 ,ns
	PC	11503	12806	12000	11014	11700	Df=3;F=1.708;P=0.169 ,ns
	NI	13097	13470	16542	13071	13603	Df=3;F=1.173;P=0.323, ns

The statistical analysis is summarized in table 5.11 given above. It has been indicated that the paddy, wheat, maize and mustard crop gives higher net income for type-I farmers the gross income from paddy, wheat and maize is higher also for type-I farmers. The gross income for mustard crop was found in type-IV farmers, with highly significant difference for all crops among all types of farmers. But the production cost of paddy is higher in type-II farmers and for wheat the production cost is higher in type-III farmers where the production cost for maize and mustard is higher in type-IV farmers. The net income from pulses and potato is higher for type-III farmers with no significant differences among all

four types' farmers. Incase of gross income and production cost for pulses crops the mean value is shown higher for type-I farmers also non significant difference for all types of farmers. The gross income for potato crops is higher for type-III farmers and production cost is higher for type-II farmers with non significant difference among all types of famers interviewed in the area.

5.12 Production cost, gross margin and net farm income of crops by farm size

Crop		Marginal	Small	Medium	Large	Av.	ANOVA (F-test)
Paddy	GI	50136	44951	47365	53217	48535	Df=3; F=8.196;0.000,*
	PC	17658	17165	17386	17937	17500	Df=3;F=.804;P=0.494,ns
	NI	32478	27785	29979	35280	31036	Df=3; F=6.28;P=0.001,*
Wheat	GI	33415	34067	40572	34789	36500	Df=3;F=13.49;P=0.000,*
	PC	15760	16120	15051	15275	15481	Df=3;F=1.914;P=0.130,ns
	NI	17655	17947	25521	19514	21020	Df=3;F= 12.92;P=0.000,*
Maize	GI	25890	22583	23408	23987	23742	Df=3; F=4.928;P=0.003,*
	PC	14701	15082	14726	15424	14966	Df=3;F=1.870;P=0.138,ns
	NI	11189	7502	8682	8563	8776	Df=3;F=4.926;P=0.003,*
Mustard	GI	9535	11287	12064	11408	11310	Df=3;F=7.784;P=0.000,ns
	PC	8918	8491	8841	8730	8743	Df=3;F=.550;P=0.649, ns
	NI	616	2796	3223	2678	2568	Df=3;F=5.079;P=0.002,*
Pulses	GI	11119	10898	9588	8436	9904	Df=3;F=7.468;P=0.000,*
	PC	9314	9227	9061	8870	8718	Df=3;F=.704;P=0.551,ns
	NI	1805	1671	1616	-434	1186	Df=3;F=.469;P=0.705, ns
Potato	GI	24773	25794	25057	25554	25303	Df=3;F=.135;P=0.939, ns
	PC	12000	12182	11357	11510	11700	Df=3;F=.986;P=0.402,ns
	NI	12773	13612	13700	14044	13603	Df=3;F=.135;P=0.939,ns

Note: * = Significant at 5% significance level, ** Significant at 10% significance level, ns= non significant

In case of paddy crop the gross income, production cost and net income was higher on large size farm. For the same crop the gross income and net income was found highly significant difference where the production cost was found non-significant difference among all farm size. For the wheat crop cultivation the gross income and net income is higher on medium farm comparing to the other farm size where as the production cost is higher on small farm size. The gross income and net income are also found significant difference for the wheat crop cultivation while the production cost is non-significant difference among the farm size. The gross income and net income is higher on marginal farm size and production cost is higher for the large farm size for maize crop. For maize crop the gross income, net income is statistically significant difference where as production cost was found non-significant difference for all farm sizes. Regarding the mustard crop

cultivation both gross and net income are higher in case of medium farm size where as the production cost is higher on marginal farm size. The gross income and net income of mustard crops are significant difference among all farm size where as production cost is non significant.

According to the data analysis for the pulses crop the gross income, production cost and Net income was found higher on marginal farm size In case of pulses only gross income is found highly significant difference among all farm size where as production cost and net income is not statistically significant difference. The small farm size of potato crop shows higher gross income and production cost where as the net income seems higher for large farm size farmers with statistically non- significant difference at 10% significant level (Table 5.12).

CHAPTER 6

FACTOR INFLUENCING PARTICIPATION IN IRRIGATION MANAGEMENT

Several factors affecting the management of irrigation schemes such as physical, institutional, Socio-economical and technical are considered to be more valuable for development and proper management of irrigation system on farmers level as well as management personnel. These factors are considered the key indicators for designing the different pathway of development approaches. The mentioned factors are necessary to be explained further aspects to analyze the response of farmers to know what would be the possible ways to find reasonable solution and gain the targeted goals. The discussion is mainly focused on these four (Physical, institutional, socio-economic and technical) factors having direct affect on the participation in development of irrigation management process.

The principal component analysis (PCA) was carried out to identify the essential interrelationships of the factors influencing farmers' participation in irrigation management. I selected 15 variables during this analysis. These factors (variables) were selected from several physical, socio-economical, and institutional aspects that tend to affect the participation in irrigation management. Varimax rotation and Kaiser Normalization was used and I selected the components with Eigen value greater than one. The Principle Component Analysis (PCA) eventually gave five components as shown in Table given below.

Table: 6.1 Results of Principal Component analysis with varimax rotation and Kaisar Normalization for fifteen household contextual variables. Numbers in bold refer to dominant variables for that component.

Variables	**Components**				
	1	2	3	4	5
Satisfaction over design and Cons.	**.783**	-.015	.157	-.086	.012
Irrigation water reliability	**.728**	.179	-.058	-.025	.145
Location of respondents	**.721**	.245	.157	-.064	-.090
Irrigation water availability	**.589**	.165	.099	.067	.079
Rewarding punishing mechanism WUA	**.579**	-.382	-.256	-.006	-.047
Fairness of water distribution	**.513**	-.243	-.018	.304	-.002
Gender of the respondents	-.031	**.736**	-.142	.011	-.065
Education of the respondents	.159	**.530**	.323	.375	-.199
Adequacy and O&M of irrigation	.221	**.529**	-.002	-.082	.109
Relationship among farmers and WUA	-.016	-.038	**.845**	.090	.110
Willingness to pay of water charge	.159	-.024	**.608**	-.282	-.068
No. of household member	-.009	-.019	-.071	**.755**	.241
Age of the respondent	.004	-.034	.073	**-.586**	.426
Total cultivated area	.052	-.135	.087	.035	**-.756**
Occupation of the respondents	.212	-.211	.169	.144	**.558**
Eigenvalues	**2.85**	**1.54**	**1.40**	**1.19**	**1.16**
%variance	**18.98**	**10.29**	**9.33**	**7.96**	**7.72**
% Cumulative	**18.980**	**29.273**	**38.605**	**46.564**	**54.282**

In every component the factors with factor carrying value larger than 0.5 are shown in bold. It was computed that the component one expressed 18.9 % of variance and integrated six factors that affect participation. It has been followed by the second component (10.2%) that consisted three factors, the third component (9.3%) have two factors, the fourth component (7.9%) have two factors, and the fifth component (7.7 %) have two factors. overall the five components explained 54.28% of cumulative variance.

The first factor, which is termed as "institution and water availability" or "natural capital" include farmers satisfaction over design and construction of physical component, Water reliability, water availability, fairness of water distribution, rewarding/punishing mechanism of WUA and location of the respondents. This factor enlightens 18.98% of the all variance and all factors were positively observed. Actuality, many farmers had their own objectives to carry out particularly farm model, and also many they intended to increase their household income. Participation in irrigation demonstrate the diversified behavior and necessary water to perform farming practice and combined with the roles and responsibilities of water users association as well as the performance of physical components.

There are three variables linked with the second factor that is gender, education and perception of farmers on adequacy and maintenance of irrigation of irrigation system. Thus the second factor has been marked as "socio-education status and perception of farmer on O&M" or "human capital". The factors enlighten 10.2 percent of entire variance. And the total factor loadings are positively observed. This factor is connected with the understanding of farmers with water users association, skill and knowledge of farmers concerning implementation of modern technology. This is being conventional that farmers who had a higher education or more energetic can have participated to several stages of participation.

The third factor includes of two variables of the Relationship of farmers with water users association and willingness to pay of water charge. This could be entitling as "individual commitments to WUA" or may be "social capital". This shows that if the WUA afford the effective activities as well as the relationship with farmers may be escalating the farmer's participation. All factor loadings have positive and this enlighten 9.3 percent out of total variance.

The Fourth factor explains of two main variables of age and number of household members. This factor could be marked as "age and family situation" or again "human capital" These variables were distinguishing the farmer's thoughts towards participation of household members. There are positive factors consignment of household members and age groups to the fourth factor and the total factor loadings are positively observed.

The associated fifth factor encompass two variables specifically cultivated area and occupation of the respondents. So the factor has been termed as "livelihoods and farming" or "Livelihood strategies". This factor explicates 7.7 percent of entire variance. The main livelihoods of the people is belongs to farming. The occupation of the respondents factor were loading positively where as the cultivated area were loading negatively.

Table 6.2: Result shown Principal Component analysis (PCA) with varimax rotation and Kaisar Normalization for twenty three household contextual variables. Numbers in bold refer to dominant variables for that component.

Variables	Components							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Income from paddy	**0.973**	.012	-.010	.032	.003	.006	.024	.012
Net Income paddy	**0.955**	.056	-.039	-.011	-.038	-.016	.016	.004
Yield of paddy	**0.903**	.033	.039	-.029	.019	-.010	.033	.048
Income from wheat	0.000	**.932**	.143	.145	-.053	.052	-.008	.117
Net Income wheat	0.079	**.901**	.178	.072	.003	.036	.021	.149
Yield of wheat	0.039	**.845**	.311	.007	-.059	.090	.034	-.060
Income from potato	-0.028	.251	**.921**	-.088	.047	-.024	.005	-.059
Net income Potato	0.011	.228	**.912**	-.077	-.057	-.015	.022	-.024
Yield of potato	0.002	.115	**.809**	.066	-.022	-.039	.020	.072
Income from pulses	-0.016	.072	-.042	**.956**	-.020	-.009	-.002	-.013
Net income pulses	-0.006	.034	.009	**.920**	-.060	.014	.056	-.033
Yield of pulses	0.012	.087	-.039	**.892**	.016	-.053	.048	-.048
Income mustard	-0.002	-.067	-.010	-.013	**.938**	.004	-.021	.085
Yield of mustard	0.040	-.025	.004	-.052	**.889**	.060	.025	.082
Net income mustard	-0.052	-.003	-.025	.002	**.867**	.044	-.043	-.101
Income of maize	-0.018	.156	-.131	-.003	.034	**.947**	-.068	-.020
Net income maize	-0.050	.185	-.157	-.046	.002	**.904**	-.011	-.082
Yield of maize	0.054	-.211	.286	-.005	.100	**.674**	-.110	.100
Owner & rented out	0.023	-.006	.018	.069	-.046	-.051	**.964**	-.076
Owner cum rentedin	-0.038	-.034	-.043	-.060	-.043	.061	**-.909**	-.207
Owner cultivated	0.032	.148	.075	-.051	.141	.082	-.133	**.753**
Total cultivated area	-0.005	-.010	.151	.012	.071	.021	-.414	**-.605**
Cropping intensity	0.048	.043	.054	-.066	-.065	-.179	.494	**.597**
Eigen values	**3.777**	**2.981**	**2.753**	**2.580**	**2.392**	**2.058**	**1.435**	**1.036**
%variance	**16.42**	**12.96**	**11.97**	**11.22**	**10.40**	**8.95**	**6.24**	**4.51**
% Cumulative	**16.420**	**29.379**	**41.348**	**52.567**	**62.967**	**71.917**	**78.155**	**82.660**

Likewise, the PCA including 23 associated variables mainly related to the income and yield of different crops resulted into 8 components and explicate 82.6% of entire variance (Table 2). Every component was subjected by at least two variables

Component one was associated to paddy (PC 1), which included gross income, yield and net income of paddy. Component two was related to wheat (PC 2) which incorporated gross income, net income and yield of wheat. Component three was interrelated to potato (PC 3) where also includes gross income, net income and yield of potato. Component four was pulses (PC 4), including gross income net income and yield of pulses. Component five was related to mustard (PC 5), which included gross income, net income and yield of mustard. Component six was related to maize (PC 6) which consisted gross income, net income and yield of maize. Component seven was related to tenancy system in the study area (PC 7), which included owner cum rented out and owner cum rented in. Component eight was related to cultivated area (PC 8), which included Owner cultivated, Total cultivated area, and cropping intensity.

It is essential to discuss different strategies for improving the irrigation system. The efficiency and reasonability of these strategies are highly reliable on the realistic situation of irrigation schemes such as the quantity of available water, dependency, equality, amount of discharge from the source and schedule of irrigation system at farmers scale. The discussion provided below will also try to give a summary of information and knowledge learned in the research area. The significance of management talents, mechanisms for improving delivery, allocation of water, skills for solution of conflicts and institutionalization by cooperation and harmonization are the key concerns discussed in this chapter.

The aspects affecting the authority and weakness of water user association, institutional limitations are highly challengeable issues; accordingly various strategies are necessary to be formulated to improve the capacity of water users association to properly run the irrigation schemes. The aspects of inefficient growth, effective policies, and violation of legal acts in payment of water rights plus improper (planning, mobilization of resources, efficient running and control) non cooperative links among water users and agencies are important to be highlighted because adverse affects has been resulted from poor relationship.

Operation as well as maintenance activities of an irrigation scheme are measured the core components that make the irrigation systems run efficiently on sustainable manner to gain the targeted goals of water management. Several factors were identified very important for proper management of irrigation schemes. The scheme may not necessarily run properly only if the users are included in the process of decision making or with handover of irrigation schemes to take the responsibilities of operation as well as maintenance. It has been recommended by several persons that scheme will run properly after it has been handed over to the users. It is opposite to the real situation to say that several irrigation schemes are not technical and complicated; the amount of water is enough in the scheme and sense of ownership, key component of participation of famers. Several factors are important for efficient running and proper management of irrigation systems. Highly effecting reasons are as follow.

- The amount of water in the system is comparable adequate and the systems are not technically complex.
- Sound sense of ownership is existed which recognized the key aspect for active participation of users.
- Users are usually surrounded by socially required rules enforced by the scheme.

Usually the required and sufficient quantity of water discharge in an irrigation scheme is highly dependable on proper and effective operation as well as maintenance. The major affecting factor is positive output gained from participation of farmers while operation and maintenance related issues. Maintenance of a canal needs sufficiently huge resources and is time consuming process as well. The fairness in amount of available water for irrigation system is vigorously linked with degree of operation as well as maintenance of the system. It has been observed in babai irrigation scheme that lack of water distribution policies and sound institutionalization has posed negative impacts on operation and maintenance.

6.1 Farmer's response regarding physical infrastructure

The operation process and maintenance requirements of irrigation systems are highly influenced by the efficiently running and physical facilities. Weak physical capacities has caused to need higher administrative inputs, that why more participation of farmers is required during the operation as well as maintenance of the scheme. The physical part has been analyzed for examining the performance of scheme. The process of evaluation has been carried out with information provided by the farmers on the physical situation and the performance of the farmers in the filed. Several indices are developed for the transformation of raw data collected from the respondents.

Table 6.3 presents the physical condition and performance of irrigation system across the three ends/reaches of the system. These reaches have been categorized according to the following criteria as suggested by the key farmers. In fact farmers themselves had long back classified the command area in to three divisions which corresponded to the head, middle and tail ends of the system. Farmers' response were categorized in to four groups ranging from "excellent" to "very poor" in order to calculate the rating index.

Physical condition and performance of different components (headwork, main system branch system and On-farm system at different location (head, middle and tail) were analyzed. The Kruskal-Wallis test is used to analyze. That's appropriate in this case, because the scale used is ordinal. The table tells us the ratings of the performance differed by type of location.

According to the output from the Kruskal-Wallis test, there is a significant difference in the components of headwork among the different location. As shown in table 5.1 the headwork performance has been rated as at the head (mean rank =95.93), at the middle (mean rank =57.51) and at tail (mean rank =46.79). The test reveals that the response of the headwork among the different location is highly significant difference (P=<0.001). The analysis also show that the performance of main system is also highly significant difference (p= <0.001) among all reaches. The performance of the branch system in different location with mean rank at head (78.39), at the middle (37.51) and at the tail (90.96) with highly significant difference (p=<0.001) among head middle and tail. Performance in the On-farm system with different mean rank values with (P=0.045) significant between location.

Table: 6.3 Farmer responses on Physical condition and performance

Physical component	**Mean rank**			**Kruskal Wallis Test (H- test)**
	Head	**Middle**	**Tail**	
Headwork	95.93	57.51	46.79	Chi square=43.276; df=2; p=0.000,*
Main system	86.05	53.05	63.50	Chi square=20.165; df=2; p=.000, *
Branch system	78.39	37.51	90.96	Chi square=51.829; df=2; p=.000, *
On-farm system	70.12	57.67	76.29	Chi square=6.190; df=2; p=.045, *

Source: Author's field survey, 2008

Note = * significance at 5 % significant level

The respondents have been asked to provide information related to their level of satisfaction on the system initially designed and constructed. The response collected from the form the farmers were classified in 4 categories ranging from highly satisfied to very poor level of satisfaction. Regarding the design and construction of physical element of the system around 37 percent farmers indicated that they were not satisfied. 19 percent of farmers were found to be totally dissatisfied. It has been exposed that the level of satisfaction is varying in different location. The farmers residing in the head region showed higher level satisfaction than those living in the middle and tail regions of the system. Table 6.4 provides an overview farmers level of satisfaction in various regions on the design and construction of physical components of the irrigation system. There are highly statistical significant difference among head middle and tail regions.

Table 6.4 Relation between Satisfaction over design and construction of physical component against location

Level of satisfaction	**Location**			**Overall**
	Head	Middle	Tail	
Highly satisfactory	10 (22)	3 (6)	1 (2)	14 (10)
Satisfactory	32 (70)	10 (21)	2 (5)	44 (33)
Not satisfactory	3 (6)	29 (60)	18 (45)	50 (37)
Very poor	1 (2)	6 (13)	19 (48)	26 (20)
Total	46 (100)	48 (100)	40 (100)	134 (100)

Chi-square value=82.964, df= 6 P= < 0.01

(Figure in parenthesis represents the percentage)

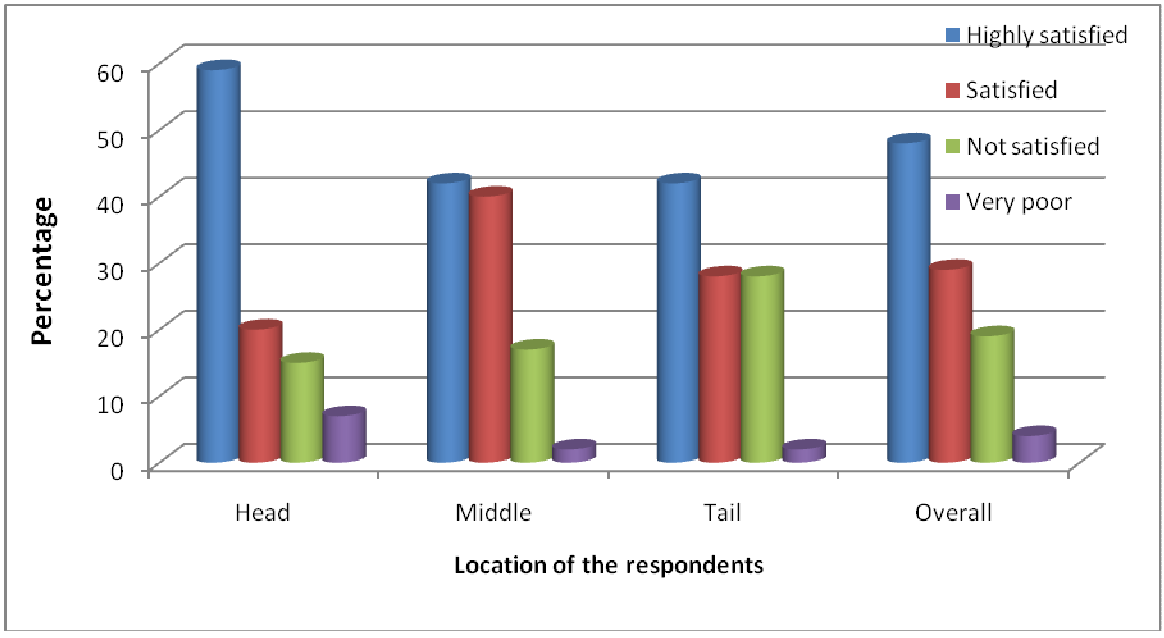


Figure 6.1: Satisfaction over design and construction of physical component

6.2 Irrigation water availability and reliability

In the Babai irrigation system, water supply is not adequate in order to meet the crop requirement. Water discharge fluctuation has been experienced in the season of crop cultivation. The distribution of water in the command area and other water management services are noticed as effectively performing by the local peoples', but the physical and economics aspects are being the major constraints.

The provision of irrigation services has been evaluated in terms of adequacy and reliability of water availability. It has been noticed that the organizational rules and regulations were performing effectively in the summer season of crop cultivation only. Normally, the distribution is practiced on rotational basis in the irrigation system that is leading to inadequate supply of water.

Questionnaire survey was used to get farmers view about the irrigation water concerned issues. The farmer were asked to rate their satisfaction level as quite satisfactory, satisfactory, not satisfactory and poor. The interview was conducted for 134 farmers in all reaches. All farmers expressed their perception about the water availability. From table 6.5, it reveals that most of the farmers from head are getting adequate water in all season. On the other hand most of the tail farmers are not satisfied with water adequacy. It has been found that the trend of water availability is in decreasing order from head to tail reaches.

It is clear from the table (6.5) that the most of the farmers from the head region (41%) are satisfactory with the current water availability. The majority of the middle region's farmers (60%) are not satisfied with the water availability. The 40% farmers from the tail region responded that the water availability was very poor, while 38% farmers are not satisfactory with water availability. The level of satisfaction on water availability has been found highly significant difference at 5% level of significance (P=<0.01).

Table 6.5 Testing water availability against location

Level of satisfaction	**Head**	**Middle**	**Tail**	**Overall**
Quite satisfactory	15 (33)	5 (10)	3 (7)	23 (17)
Satisfactory	19 (41)	9 (19)	6 (15)	34 (25)
Not satisfactory	9 (20)	29 (60)	15 (38)	53 (40)
Poor	3 (7)	5 (11)	16 (40)	24 (18)
Total	46 (100)	48 (100)	40 (100)	134 (100)

Chi-square value= 42.675, DF= 6, P= <0.01,

Source: Authors' field survey 2008

Note: The figure in parenthesis represents the percentage

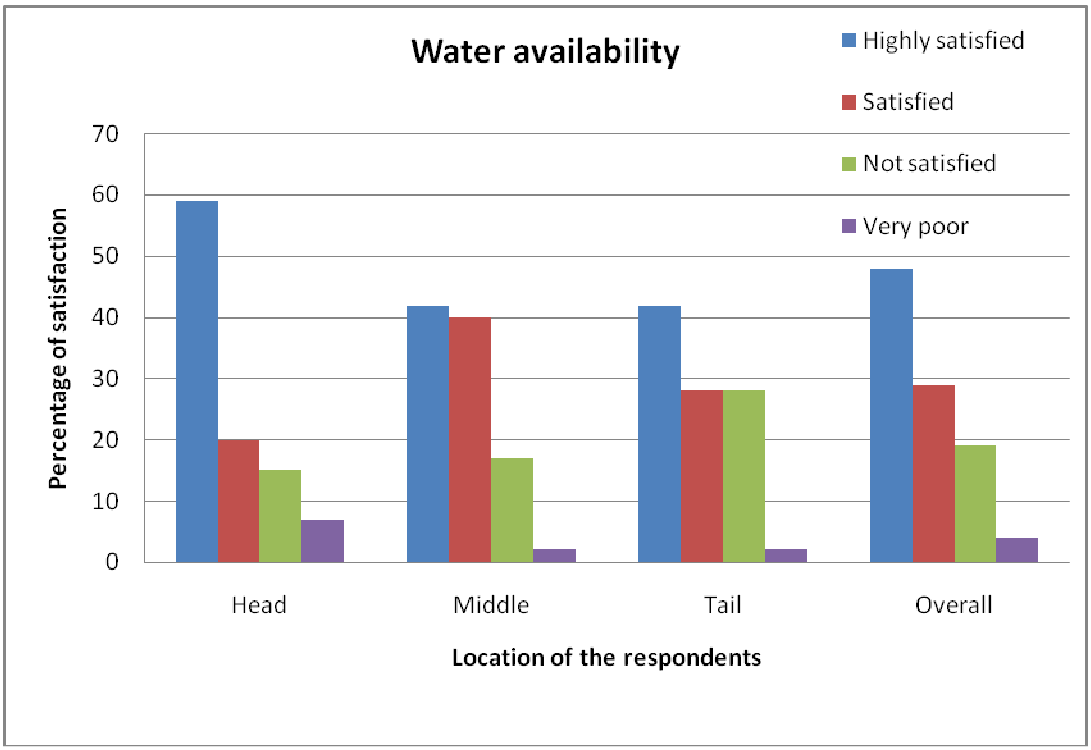


Figure 6.2: Water availability in different farm location

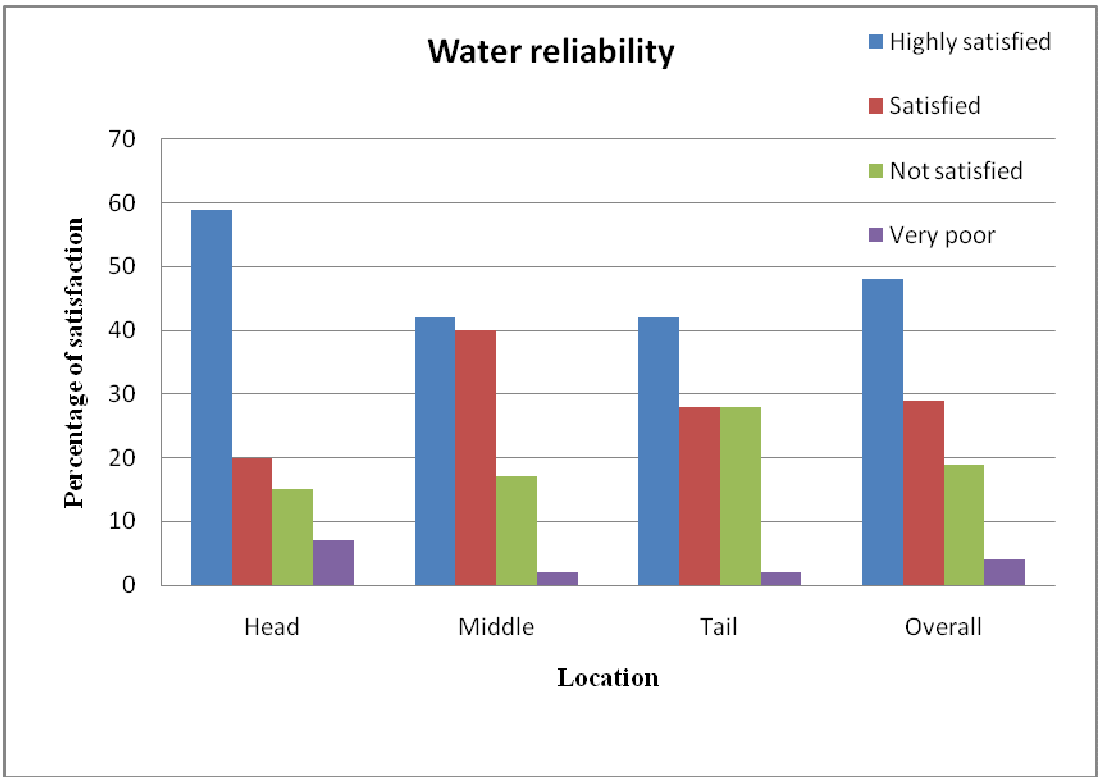


Figure: 6.3 water reliability in different farm location

Water reliability is another parameter which has been used to measure the service level in the scheme. In Table 6.6 the percentage of farmer expressing the water reliability in four level of satisfaction is arrayed. The farmers from the head ends felt that the water is satisfactory reliable as compared to middle and tail end farmers felt less reliability of water supply meaning that they are not having water with confidence. From head to the tail region the level of satisfaction of farmers is decreasing. Tail farmers are not getting water at the time of need and as per planned schedule. The rotation of water starts from head to tail. There is statistically significant difference among all reaches.

Table 6.6 Testing water reliability against location

Level of satisfaction	Head	Middle	Tail	Overall
Always	9	3	2	14
	(20)	(6)	(5)	(10)
Usually	29	9	2	40
	(63)	(19)	(5)	(30)
Only sometime	8	35	18	61
	(17)	(73)	(45)	(46)
Rarely	0	1	18	19
	(0)	(2)	(45)	(14)
Total	46	48	40	134
	(100)	(100)	(100)	(100)

Chi-Square= 87.026 DF= 6 P= <0.01
Source: Authors' field survey, 2008.
(Figure in parenthesis represents the percentage)

6.3 Operation and maintenance activities

The operational activities in Babai irrigation system were classified into four different activities based on the farmer's level of satisfaction: Acquisition of water, allocation among branches, distributions of water among farmers and application of water in the field. The farmers were inquired to deliberate their response regarding the operational activities in the irrigation system.

According to Kruskal-Wallis test showing that the responses of operational activities among different locations for acquisition of water the farmers at the head region are highly satisfied with a mean rank value of 102.41 that those in the middle and tail regions with mean rank values of around 56 and 40 respectively.

The acquisition of water in different regions have been found significant different. Regarding the allocation of water among braches the head regions indicated higher satisfaction comparing to the middle and tail regions. The allocation of water was found significant different in different locations. The farmers at the head regions also expressed higher satisfaction about the distribution of water with significant different. It reveals that the farmer at the head regions is highly satisfied in operational system except the application of water showing higher satisfaction for the middle region farmers (table 6.7).

Table 6.7 Relation between satisfaction of farmers on operation system and location

Operational activities	**Mean rank**			**Kruskal Wallis Test**
	Head	Middle	Tail	**(H- test)**
Acquisition of Water	102.41	56.80	40.19	Chi square=66.659; df=22; P=0.000
Allocation of water among branches	92.08	53.16	56.45	Chi square=30.607; df=2; p=.000
Distribution of water among branches	78.93	55.49	68.76	Chi square=9.488; df=2; p=.009
Application of water in the fields	60.64	79.68	60.78	Chi square=8.302; df=2; p=.016

Source: Author's field survey, 2008

The adequacy level of maintenance activities was analyzed in the Babai irrigation system. The level of adequacy was ranked into four different classes such as fully adequate, fairly adequate, inadequate, and fully inadequate. According to the data collected through survey, about 38 percent farmers revealed that the existing maintenance activities are inadequate to provide the reliable and adequate provision of water to the farmers' field. Nearly, 12 percent of farmers respond that maintenance activities are totally inadequate according to the requirements of the irrigation system. However, nearly 20 percent of farmers from head region, 58 percent from middle region and 35 percent from tail region were expressed that the maintenance activities are inadequate in the irrigation system. It was observed that there is a huge problem of heavy siltation in the head (upstream) region of the main canal that is also leading to siltation in the farmers' fields in the command area of the irrigation system. Farmers located at the tail of the irrigation system were found to be getting less irrigation services due to lack of proper maintenance related means like leakage of water from canal at upstream side (Table 6.8). The adequacy of maintenance activities is highly significant difference among all reaches.

Table 6.8 Relation between perceptions of level of adequacy of maintenance activities

Adequacy of maintenance	**Location of the respondent**			**Overall**
	Head	**Middle**	**Tail**	
Fully Adequate	18 (39)	4 (8)	6 (15)	28 (21)
Fairly adequate	17 (37)	12 (25)	10 (25)	39 (29)
Inadequate	9 (20)	28 (58)	14 (35)	51 38%
Totally inadequate	2 (4)	4 (8)	10 (25)	16 12%
Total	46 (100)	48 (100)	40 (100)	134 (100)

Chi-square value=30.968, DF= 6, P=<0.001

(Figure in parenthesis represents the percentage)

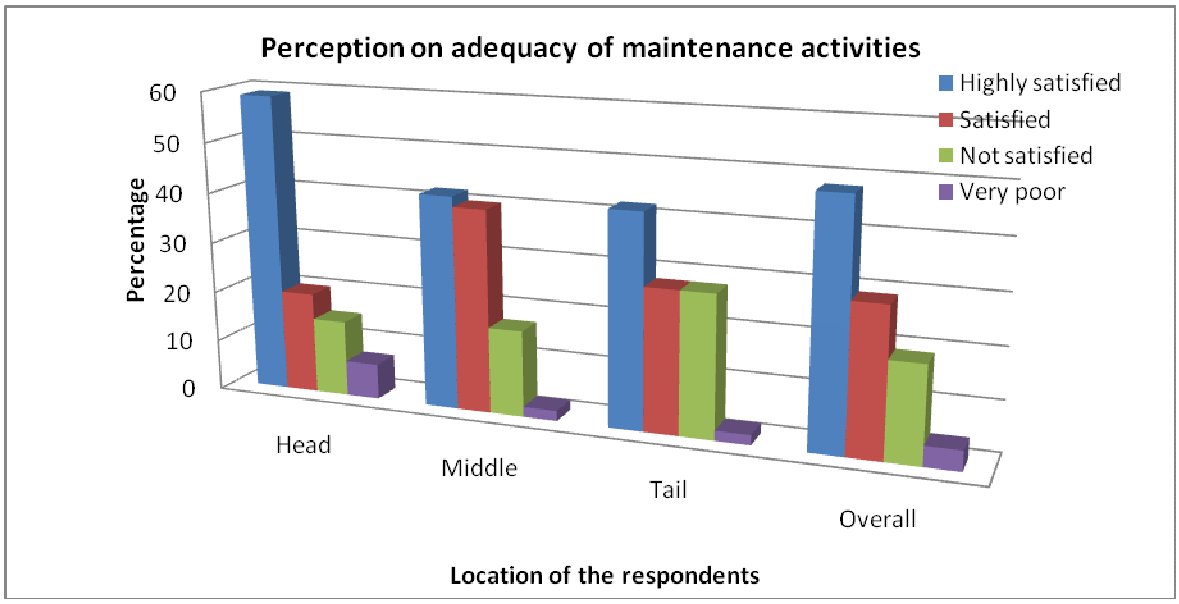


Figure: 6.4 Perception of farmers on adequacy of maintenance activities

6.4 Willingness to pay water charge and perception on WUA

6.4.1 Willingness to pay for water charge

Regarding the willingness of payment issues of water quantity and relevant, the farmers have been questioned that to what extent they are willing to pay in case of efficient water availability and relevant services. At present per bigha charges of irrigation services are equal to Rs.120 for each farmer. The table 6.9 summarizes the farmer willingness' to pay for irrigation fees. The data indicates that overall 23 percent farmers are not interested to pay more for irrigation fee because they think that the currently existing water charges are already higher. The overall 55 percent of farmers mentioned that they are willing to pay 20 percent more if the water availability and related services is improved. The farmers who are willing to pay more than 50 percent irrigation charges are found about 14 percent of the total farmer interviewed. The farmers which are willing to pay 100 percent more are about 8 percent. Most are the farmers willing to pay more than the existent charges are living in the tail region where water shortage issues are serious. However, the willingness to pay more than the regular charges among all location is not significantly difference. Generally all farmers are paying regular irrigation fee in all regions of the irrigation system.

Table: 6.9 Willingness to pay for irrigation fees in different locations

Willingness to pay (more than existing water charge)	Location			Overall
	Head	Middle	Tail	
not willing to pay more	13 (28)	11 (23)	7 (18)	31 (23)
willing to pay 20% more	27 (59)	25 (52)	21 (52)	73 (55)
willing to pay 50% more	4 (9)	10 (21)	5 (12)	19 (14)
willing to pay 100% more	2 (4)	2 (4)	7 (17)	11 (8)
Total	46 (100)	48 (100)	40 (100)	134 (100)

Chi- square value=9.853a df= 6 P=0.131
(Figure in parenthesis represents the percentage)

6.4.2 Perception of farmers on WUA

In order to assess the effectiveness and performance of the organization for the operation and maintenance of the Babai irrigation system, the farmers were inquired to show their satisfaction over WUA. Sampled household were asked to express their thinking about some major issue related to WUA and its rules of BIS and its implementation.

The farmers in the BIS were questioned to view about the important issues of irrigation services managed by water user associations. The farmers were questioned to express about their level of satisfaction from the services which are carrying out by WUA and parties involved in the management issues.

Table 6.10 provides an overview of the statistical analysis carried out the satisfaction of farmers on WUA. The information is mainly focused on the level of satisfaction of farmers with the irrigation services providing by WUA in different regions of BIS. It is indicated that 48 percent farmers are highly satisfied with WUA in term of their service provisions. Overall 19 percent farmers showed to be unsatisfied but majority of farmers from the tail regions which are about 28 percent. It reveals that the WUA is having better relationships with farmers. The level of satisfaction of and farmers in all regions is non-significantly difference.

Table 6.10 Satisfaction of farmers with WUA against location

Satisfaction of farmers from WUA	Location of the respondent			Overall
	Head	Middle	Tail	
Highly satisfied	27	20	17	64
	(59)	(42)	(42)	(48)
Satisfied	9	19	11	39
	(20)	(40)	(28)	(29)
Not satisfied	7	8	11	26
	(15)	(17)	(28)	(19)
Very poor	3	1	1	5
	(7)	(2)	(2)	(4)
Total	46	48	40	134
	(100)	(100)	(100)	(100)

Chi-square value= 8.465 DF=6, P=.206

(Figure in parenthesis represents the percentage)

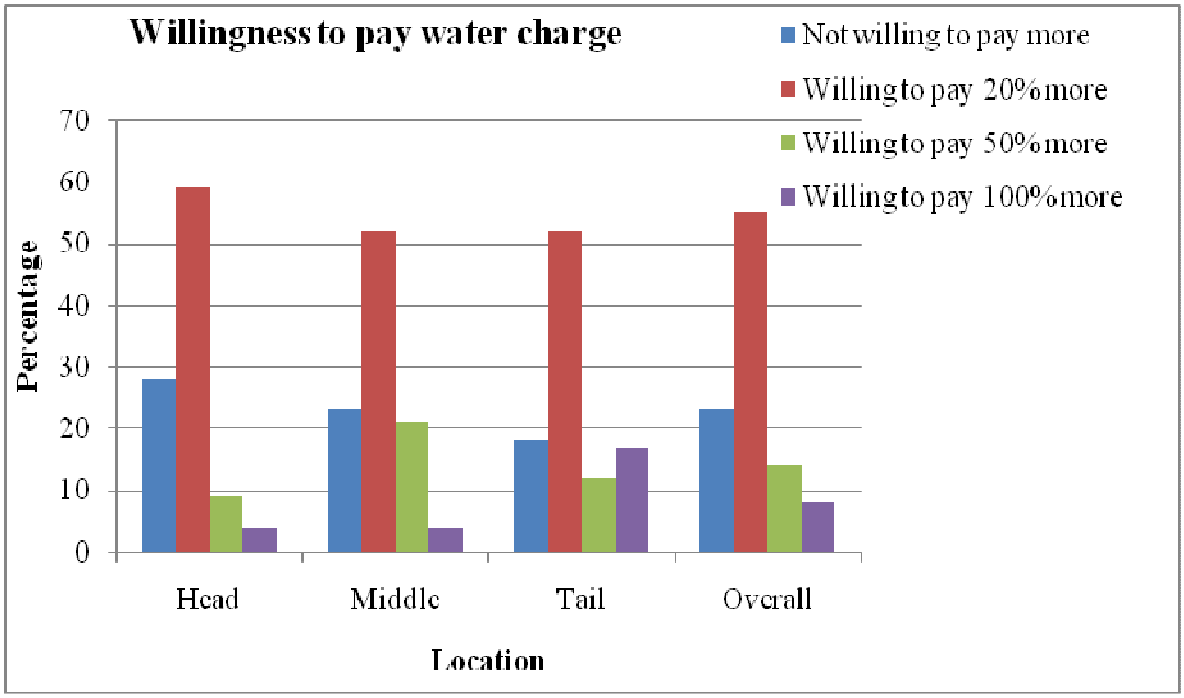


Figure 6.5 Willingness to pay for water charge

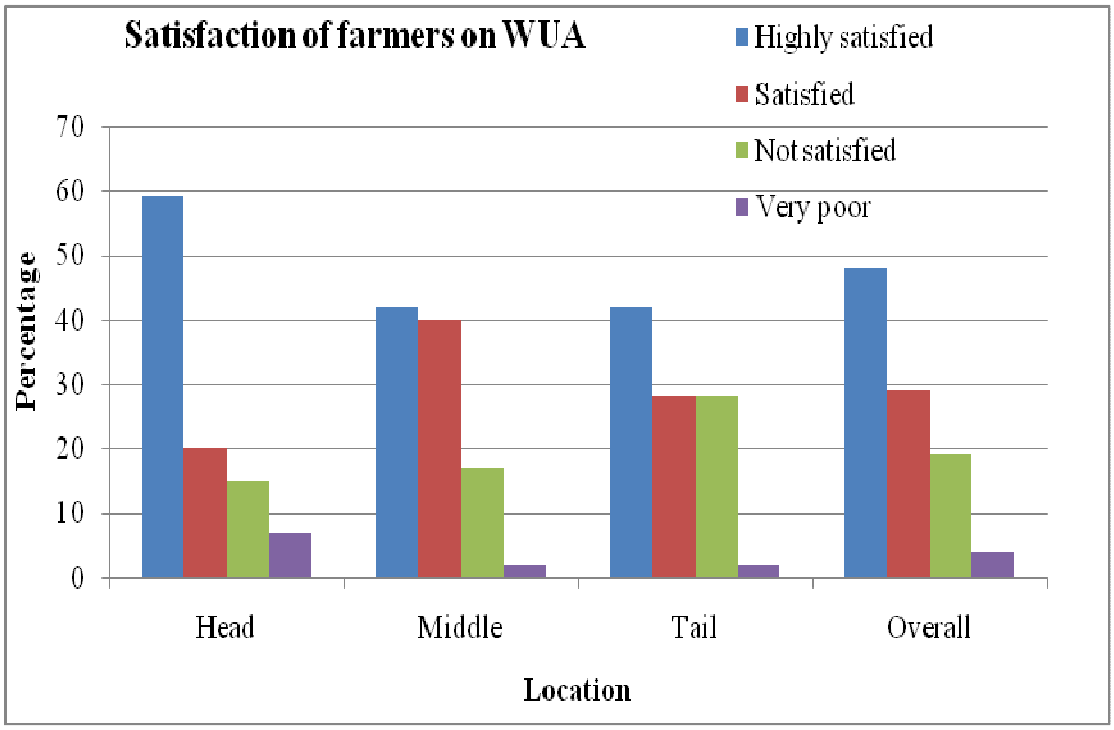


Figure 6.6 Relationship between farmers and WUA

6.4.3 Effectiveness of Water Users Association in different activities

The respondents were also inquired about the effective performance of the water user organization for different management activities. In order to evaluate the level of effectiveness, management activities were classified based on satisfaction index into four different groups such as allocation and distribution of water, maintenance of irrigation system, resource mobilization, and conflict management.

According to the Kruskal-Wallis test applied to find out the effectiveness of Water user's association in different activities such as allocation and distribution of water, maintenance of irrigation system, resources mobilization and conflict resolution in different regions based on the Farmers' response. Attributes regarding effectiveness of WUA are assessed in terms of weightage indices. Table 6.11 summarizes the result obtained from the responses gathered from the farmers which indicates that farmers at tail regions expressed allocation and distribution of water is highly effective showing the valve of 86.56 as a mean rank while the mean rank of 48.58 in the head regions indicates that the effectiveness is lower than at the middle and tail. Effectiveness of allocation and distribution of water in all three regions have been found significant difference. Effectiveness of WUA in terms of maintenance of irrigation system, resources mobilization and conflict resolution has been found highly effective at middle regions comparing to head and tail regions. The data indicates that the effectiveness of maintenance of irrigation system, resources mobilization and conflict resolution is lower at head region. Effectiveness of WUA in maintenance of irrigation system is significant different at 5% level of significance and the effectiveness in conflict resolution has been found to be significant difference at 10% level of significance among all regions. Activities of WUA in resource mobilization are non-significant difference among all regions.

Table 6.11 Effectiveness of water user's association in different activities

Effectiveness of WUA	**Mean rank**			**Kruskal-Wallis(H-test)**
	Head	Middle	Tail	
Allocation and distribution of water	48.58	69.75	86.56	Chi-square=24.248; df=2; P=0.000
Maintenance of irrigation system	57.78	76.52	67.85	Chi-square=6.240; df=2; P=.044
Resource mobilization	61.79	73.71	66.61	Chi-square=2.606; df=2; P=.272
Conflict management	59.99	76.40	65.46	Chi-square=4.825; df=2; P=.090

Source: Author's survey, 2008

6.4.4 Satisfaction over rewarding and punishing mechanism of WUA

The rules and regulation and sound polices are very important factors influencing the effectiveness, operation and maintenance of irrigation scheme in order to ensure sustainability of the system. Regarding the rewarding and punishment mechanism of WUA the farmers were asked to express their view. The data collected regarding this issue is from the farmers are analyzed and summarized in the table 6.12 given below. It is indicated that only 10 % of farmers in all regions ranked as very good. The farmers satisfied with the rewarding and punishing mechanism of WUA is 25% whereas, 27% farmers are not satisfied with mechanism. However, the farmers of 38% who were totally dissatisfied the current rewarding and punishing mechanism of WUA in all regions. The detail of different rank of satisfaction of farmers in all regions is tabulated below.

Table: 6.12 Satisfaction of farmers over rewarding and punishing mechanism

Rewarding and punishing mechanism	Location			Overall
	Head	Middle	Tail	
Very good	7 (15)	7 (15)	0 (0)	14 (10)
Satisfactory	15 (33)	11 (23)	7 (18)	33 (25)
Not satisfactory	16 (35)	9 (19)	11 (28)	36 (27)
Poor	8 (17)	21 (44)	22 (55)	51 (38)
Total	46 (100)	48 (100)	40 (100)	134 (100)

Chi square value=18.882 df=6 p=0.004

(Figure in parenthesis represents the percentage)

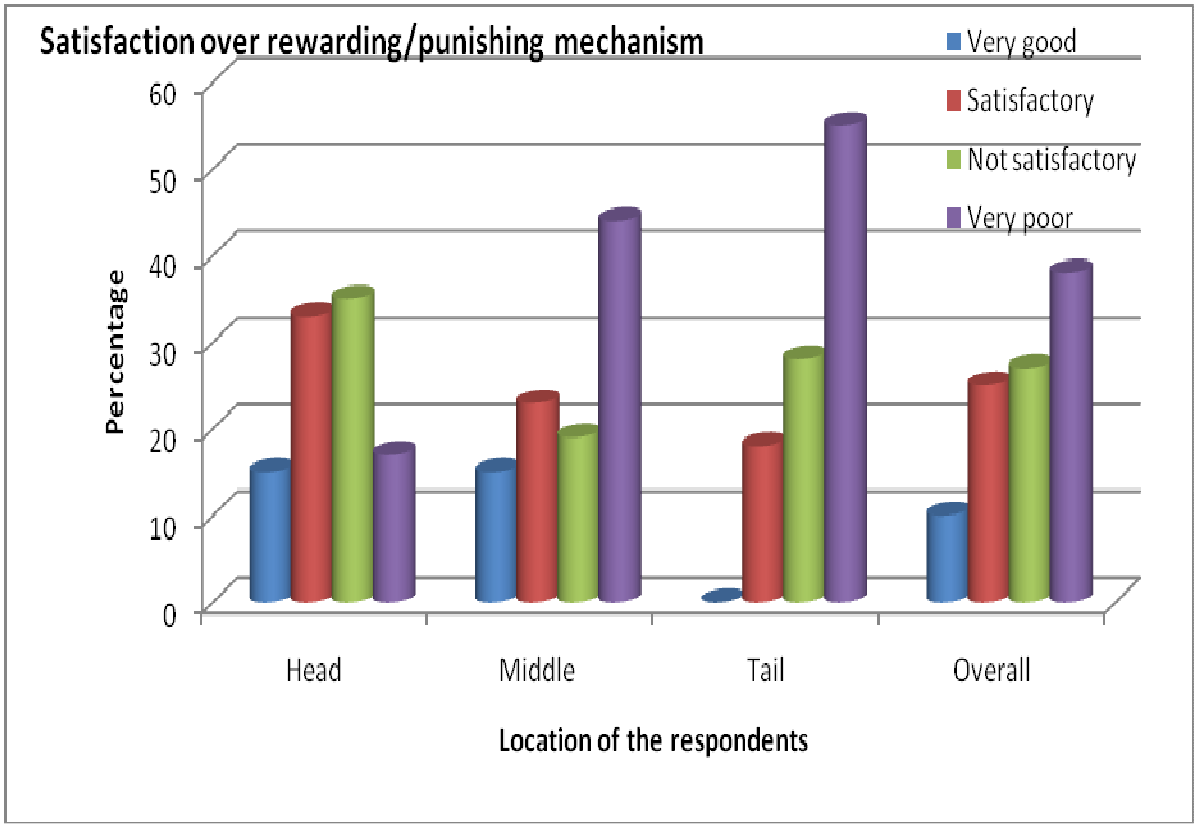


Figure 6.7 satisfactions over rewarding/punishing mechanism of WUA

CHAPTER 7

EXTENT AND PROSPECT OF PARTICIPATION IN IRRIGATION SYSTEM

7.1 Peoples' involvement in development and other activities

In the initial days of settlement, people have shown strong social cohesiveness due to difficult livelihood in the command area of Babai irrigation system. Socio-religious and other different development activities have proved the participation of people. It has been investigated that older settlers of the command area have shown higher level of participation in different local activities than the new settlers.

In order to assess the level of involvement of the farmers, all the community development related activities were classified into three different groups like "local development activities", "social campaign" and "social religious activities". Local development activities include improvement in infrastructure. Social campaign refers to activities such as afforestration, livestock development, health and sanitation etc. Socio-religious activities refer to religious and cultural activities.

The frequency of people participation was assessed of the above mentioned activities through rating from "always" to "rarely". Farmers were inquired to express their intensity of participation in different activities. Index of the participation was calculated according to the given guidelines in the methodology.

As mentioned above, the people from the Babai Irrigation system were found to be usually participating behavior in the different community activities. The overall participation from different farm size is found as better. Under construction and development activities the farmers with medium farm size were found highest degree of participation (Mean rank=77.14). While farmers with large farm size were reported as less degree of participation (mean rank=56.73). (Table 7.1), In case of social campaign the farmers from the large size were found higher level of participation than other farm sizes with highly significant difference (P=<0.001). Similarly the activities related to social and religious, marginal farmers have less participation and the large farmers have higher participation with significantly difference (P=< 0.05).

Table 7.1 Participation index in different activities by farm size

Activities	**Mean rank**				**Kruskal-Wallis(H-test)**
	Marginal	small	Medium	Large	
Cons. And dev. Activities	64.91	64.70	77.14	56.73	Chi-square=6.368; df=3; P=.095
Social campaign	40.02	79.64	68.40	72.83	Chi-square=21.090; df=3; P=.000
Social and religious	49.25	70.55	68.98	75.12	Chi-square=8.405; df=3; P=.038

Source: Author's Survey, 2008

The farmers from head and middle region have shown higher degree of participation in compare to the tail region in case of construction and development activities there is no significant difference between participation index of head middle and tail region respondents. Regarding social campaign the farmers from the middle region have

expressed slightly higher mean rank (69.97) than other region along with no significant difference among all reaches. In case of social and religious activities the farmers from head region have higher mean rank (68.65) but it is found to be non-significant difference. It is concluded that farmers from different regions of Babai irrigation system are participating with a great zeal in different development activities. (Table 7.2)

Table 7.2 Participation index in different activities by location

Activities	**Mean rank**			**Kruskal-Wallis(H-test)**
	Head	Middle	Tail	
Cons. And dev. Activities	70.63	70.00	60.90	Chi-square=1.881; df=2; P=.390
Social campaign	65.08	69.97	67.33	Chi-square=.532; df=2; P=.766
Social and religious	68.65	67.50	66.18	Chi-square=.116; df=2; P=.943

Source: Author's survey, 2008

Framers' participation in irrigation development activities was classified into four different stages such as "conceptualization", "planning", "construction and implementation" and "operation and maintenance". Only very few of the respondents have been used to be participated during the conceptualization and planning stage of development in irrigation system. Where as, nearly one half of the respondents were participating in the construction and implementation of the physical infrastructure and implementation stage of the Babai Irrigation system. It will be very pleased that almost all farmers have been their part of participation in the operation and maintenance related activities of the irrigation system (Table 7.3).

Table 7.3 Participation at different stages of irrigation development by location

Stage of development	Location						Chi-Square test
	Head		Middle		Tail		
	Yes	No	Yes	No	Yes	No	
Conceptualization	13	87	17	83	10	90	Value=.843, Df=2,P=0.656
Planning	20	80	19	81	25	75	Value=.591; Df=2 P=.744
Construction and Implement	41	59	44	56	50	50	Value=.686; Df=2 P=.710
Operation and maintenance	93	7	88	12	95	5	Value=1.893, Df=2,P=.388

Source: Author's field survey, 2008

While analyzing the degree of participation of farmers, it has been noted that higher percentage of farmers were participated in the construction of physical components of infrastructure of branch canal and some other on-farm activities. It has also been experienced that the farmers from the head region were expressing their higher participation than the farmers from the middle and tail regions with less degree of participation in the construction related activities in the irrigation system (Table 7.4).

Table7.4 Participation at implementation of irrigation activities by location

Physical component	**Location**						**Chi-square test**
	Head		Middle		Tail		
	Yes	No	Yes	No	Yes	No	
Headwork	80	20	40	60	55	45	Value=15.689,Df=2, P=0.000
Main system	65	35	56	44	40	60	Value=5.581, Df=2 ,P= 0.061
Branch system	57	43	67	33	68	32	Value=1.449, Df=2, P=0.485
On-farm system	70	30	77	23	68	32	Value=1.135,Df=2, P=0.567

Source: Author's field survey, 2008

7.2 Willingness to participate and contribute in O&M

As, it has been already mentioned above, that the farmers from BIS have record of their participation in different development activities at different levels with varying degree of participation. In order to evaluate the willingness and capacity of farmers to take part and contribute their share in the O&M of the Babai irrigation system, data have been collected from the respondents. So, farmers were inquired to show their level of satisfaction from the existing provision of irrigation services in response of your contribution in the O&M of the irrigation system. Overall, farmers have been expressed their willingness to participate in O&M activities of irrigation system with one constraint of funds availability in case of emergency maintenance activities. The result from analysis of interested in participation in operation and maintenance shows that an average of 43 percent farmers was found with high willingness to participate. The farmers showed fairly participation in operation and maintenance is around 41 percent. 12 percent farmers are found to show that they have not much willingness to participate in operation and maintenance activities where as the farmers who do not want to participate at all are only 4 percent. It reveals that majority of the farmers in the system have higher willingness to participate in operation and maintenance related issues. The participation in O&M is significantly difference among all reaches. The detail of different location wise willingness to participate is given in table 7.5.

Table 7.5 Willingness index to participate in Operation and maintenance

participated in O&M	Location			Overall
	Head	Middle	Tail	
Highly	25	13	19	57
	54%	27%	48%	43%
Fairly	15	24	16	55
	33%	50%	40%	41%
Not much	6	5	5	16
	13%	10%	12%	12%
Not at all	0	6	0	6
	0%	12%	0%	4%
Total	46	48	40	134
	100%	100%	100%	100%

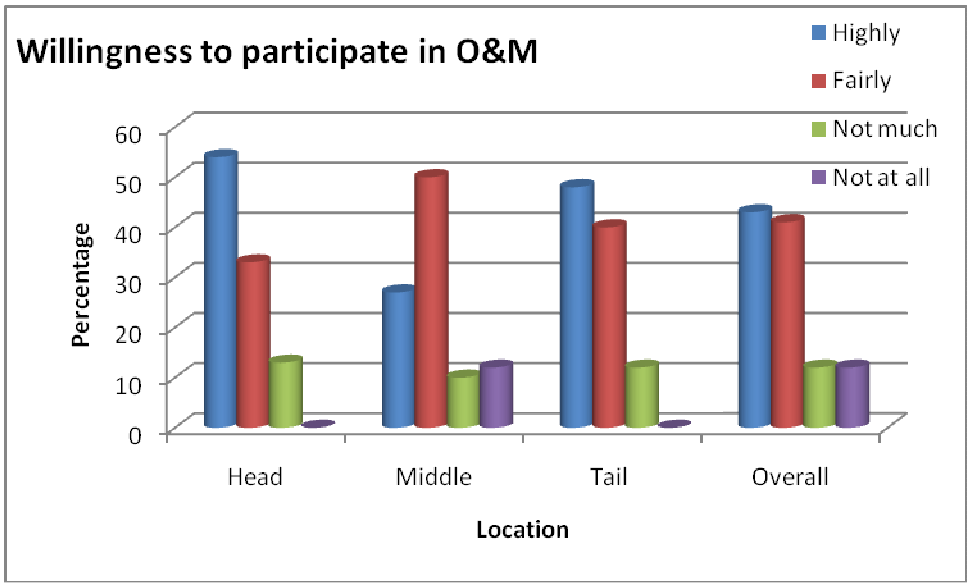


Figure 7.1 willingness to pay participate in O&M of irrigation system
Chi-square=17.082; DF=6; P=0.009

According to the farmers, it is very difficult for farmers to run the irrigation system even for a single year without financial and technical support from the government. So, on the other hand, farmers were expressing their willingness to participate in the operation and maintenance related activities with the committed support and help from the government. It has been noted that about 13 percent of the farmers expressed their willingness that they can operate the whole irrigation system, about 28 percent were looked to operate the system except headwork, while 31 and 28 percent farmers were expressed their willingness to operate the branch canals and on-farm systems respectively.

The most of the farmers from the head region (63%) expressed the opinion that they were able to operate the irrigation system except headwork. The majority of the middle region farmers (58%) showed their ability to operate the branch system. Half of the tail end farmers think that they are able to operate only on farm system. These all results have significance at < 0.001 level (Table 7.6).

Table 7.6 Ability to operate the physical component of the system

Level of system	Head	Middle	Tail	Overall system
Complete irrigation system	13	1	4	18
	28%	2%	10%	13%
Except headwork	29	3	5	37
	63%	6%	12%	28%
Branch system	3	28	11	42
	7%	58%	28%	31%
On-farm system only	1	16	20	37
	2%	33%	50%	28%
Total	46	48	40	134
	100%	100%	100%	100%

Chi-square value= 83.635, DF=6, P=<0.001

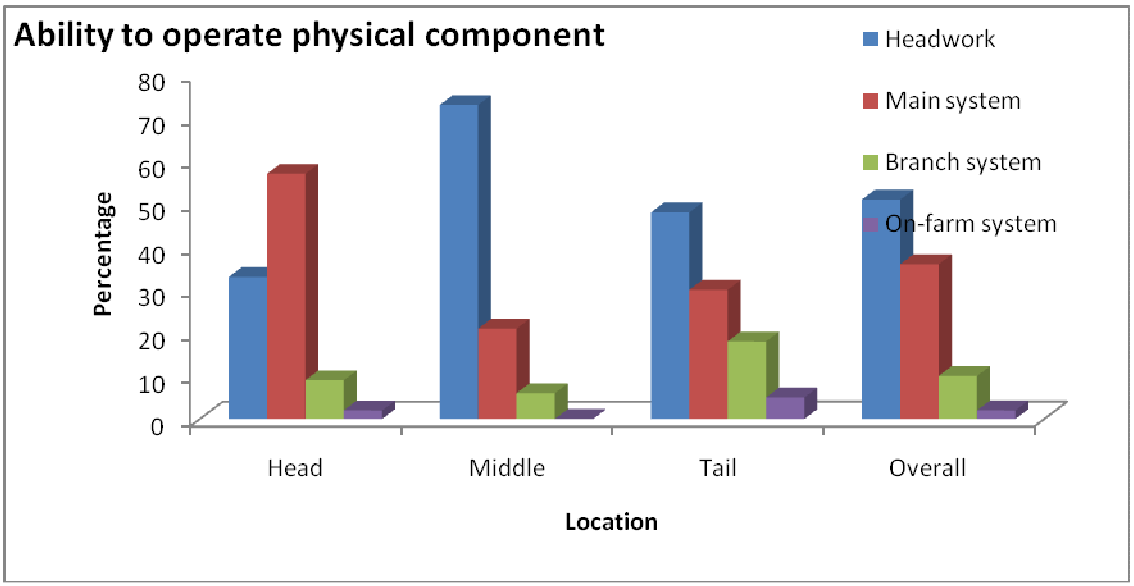


Figure 7.2 Farmers ability to operate physical component

In order to operate the canal irrigation system by farmers, they were inquired about their willingness to take over the responsibilities of the operation and maintenance of the irrigation system at what minimum assistance required. It has been found that farmer were required more than 51 percent of resources needed for O&M of the headwork of the irrigation system. Likewise, 36 and 10 percent resources were required by the farmers in order to O&M of the main and branch canal respectively in the Babai irrigation system The most of the farmers located at the head region (57%) needed assistance at main system, where as 73% and 48% located at middle and tail regions respectively need assistance at headwork component. The farmers need minimum assistance at the on farm system. Overall the farmers need the maximum assistance at the headwork (Table 7.7).

Table 7.7 Average of minimum assistant needed for O&M

Components of physical system	**Location of the respondents**			**Overall system**
	Head	**Middle**	**Tail**	
Headwork	15 33%	35 73%	19 48%	69 51%
Main system	26 57%	10 21%	12 30%	48 36%
Branch system	4 9%	3 6%	7 18%	14 10%
On-farm system	1 2%	0 0%	2 5%	3 2%
Total	46 100%	48 100%	40 100%	134 100%

Chi-square value=21.766, DF=6, P=<0.001

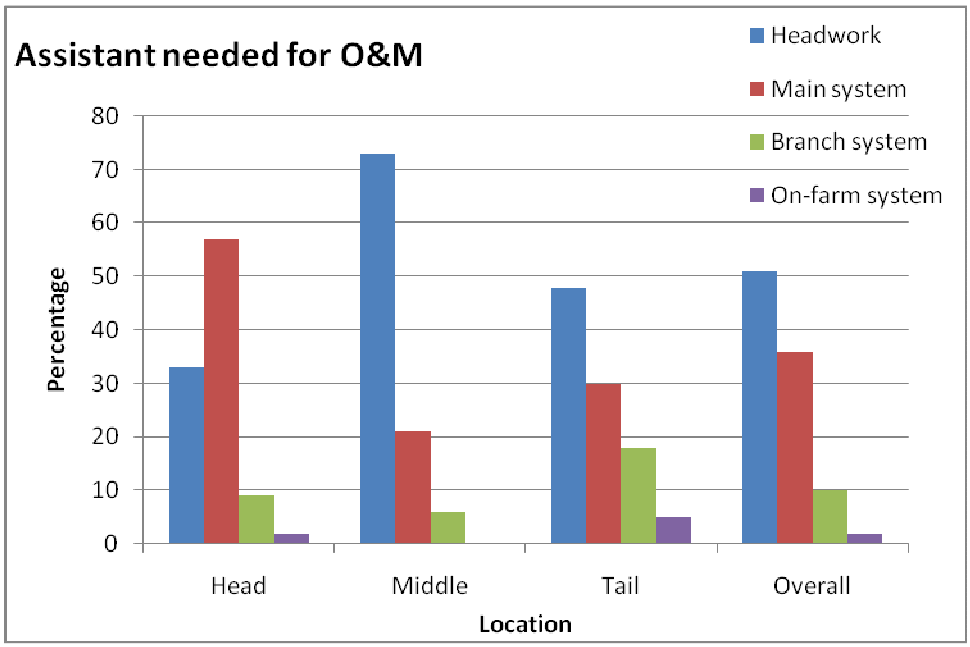


Figure 7.3 External assistant needed for operation and maintenance

It has been noticed that farmers have variability in terms of response from the different regions of the irrigation system regarding the minimum assistance needed to O&M of the system. The farmers from the middle region were expressed about the higher external support for the proper operation and maintenance of the irrigation system and its physical components such as headwork.

7.3 Farmer's organizations

Farmers would participate in the implementation, operation and maintenance of the project through water user groups (WUG). A WUG would be established for each tertiary outlet command servicing groups of farms of about 20-25 ha before irrigation would be supplied. Each WUG would be represented by a leader and sub leaders elected by the farmers for the 10-12 ha sub groups. The main tasks of the WUG's would be to supervise proper implementation of rotational supply schedules below the tertiary outlets and with in the commands of the tertiary turnouts. It would also play a key role in the planning, construction and operation and maintenance of field channels with in the 10-12 ha. Units commanded by a tertiary turnout .A water users section would be setup with in the projects agricultural division to organize farmers in WUGs. This section would closely coordinate with the operation section under the operation and maintenance division of the project in the field of water management and in particular, with regard to the planning design and construction of field channels. The consultants would assist in formulating the basic criteria for the planning, design and construction of the field channels. An assurance would be obtained from government that it would take systematic steps to ensure that (i) Water users groups would be established in all tertiary units throughout the command area in concert with construction progress but at least six months before the scheduled commissioning of the distribution networks; (ii) sound water distribution schedules would be prepared for each tertiary unit in consultation with the water user groups.

The major responsibility of water user coordination committee (WUCC) is to mobilize the available resources for *O&M* of the irrigation system. It coordinates with the public

authorities in order to find out necessary assistance and responsibility to allocate and regulate water among canal branches. It also involves in the conflict management within the command area of irrigation system. Where as, the water user board committee (WUBC) is responsible to mobilize resources of *O&M* at main canal level, branch canal as well as on-farm system. It has also been involved in conflict resolution and monitoring the water distribution among farmers in the entire command area of the branch canal.

The executive management committee of the Babai irrigation project has been legally institutionalized under the law, rules, and regulation of government of Nepal. It has its constitution and the general assembly of water user has been approved it. All farmers from the command area of Babai irrigation system have the membership based on the constitution of the Babai irrigation system. Water organizations perform their activities following the constitution and its mechanism of the management central committee. In order to the adequate and reliable provision of the water related activities, farmers of BIS must have to undertake the timely decisions and seasonally water requirement. The management committee calls the assembly meeting annually to assess the maintenance needs, mobilization of existed resources, required resources and to set the planning activities for better *O&M* within the irrigation system. The farmers have to follow the proposed schedule in the assembly meeting during the whole year.

The WUA has right to operate the system under the accepted norms of the main committee. WUAs hold the power to bargain and negotiate with the government and other agencies. Sole responsibility of the WUA is to maintain satisfactory irrigation service and setting up acceptable procedures to ensure payment. Nevertheless, the WUAs are more concern over the efficient management of irrigation water and the financial sustainability of the project. Other responsibilities of the WUAs are:

- Establishment of mutual cooperation between the users' and repair and maintenance of the canal
- Execution of irrigation schedules as per the irrigation rules
- Equitable distribution of water and effective collection utilization of Irrigation charge
- Increasing the access of non-users to this irrigation system
- Monitoring the activities of the users and providing punishment to those who violate the rules

Main committee decides the rate of irrigation charge by general assembly. At present, the level of charge is NRs. 120 per bigha irrespective of the amount of water used. Tertiary committees are responsible to collect the fee from their respective tertiary. Users' main committee and Middle Irrigation Development Division, formulate rules for water distribution. They do so for equitable distribution of water considering the availability and necessity of the water.

District Irrigation Office and main committee are responsible to regulate the irritation water and cleaning and maintenance of the main and link canals. Desilting in the main canals is done by the DOI. In case of branch canals and tertiary it is done by respective users' committee. Nevertheless, farmers have important role in management of water and in care and maintenance of the canals.

Table 7.8 Roles, responsibility, rules and sanction for operation and maintenance

Activity	**Organizational control**	**Constitutional arrangement**
1.Acquisition of water at source	Central committee of water users cares the organizing, decision making, resources mobilization and supervision of the acquisition issues	WUCC is formal agency which takes required actions. The actions of WUCC needs to approved before action by general assembly of water users
2. Allocation and distribution of water in various branches	The flow in the main canal is not intervened (Only in case of extreme water scarcity or during any conflicts WUCC intervenes)	In normal situation, water will be allowed based on the structure of the intake of different branch canal. WUCC can take decision about allocation process as and when necessary
3.Assembling and allocation of different resources of improvement the main system	WUCC usually decides the requirement for improvement, making plan, requests for contribution (external or internal). The resources contribution by branch canal should be adjusted according to the capacity of intake pipes of each branch	The branch committee have the responsibility to find the procedure for generating the resources from different branches
4.Allocation and distribution of water at branch level in all farmers	WUBC takes decisions regarding the irrigation schedules for water users in respective branches	Concern branch committee formulate the rules and regulation and authorize WUBC to take required actions related to allocation as well as distribution of water
5.Actions required for improvement and maintenance of ditches in various farms	WUBC recommends the farmers of related sub-regions to take care the farm ditches as well as field channels along with the concerned fields	No particular action is mentioned
6. Conflict resolution arising during water allocation and mobilization of resources	a) Local conflicts management through Sub-region committee b)WUBC manage the complicated conflicts as well as conflicts at branch canal c)WUCC for pending conflicts at main system level	If the conflicts remain unsolved at branch and main system level, the higher tire will take action to solve the conflicts
7. Fine and sanction	a. WUBC charge the fines if the rules and regulation are broken b. WUCC usually makes rules for sanction or fine	WUCC and WUBC are responsible to implement and supervise the rules and regulations in the irrigation system

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1 Conclusions

An attempt was made to describe the factors and impact of participation on the operation and maintenance of an irrigation system by taking a case study of Babai irrigation system. The overall objective of the study was to identify and evaluate motives, factors, constraints and opportunities for farmer to participate in the management of irrigation schemes in order to suggest recommendations for improving efficiency of farmer-managed irrigation systems and to document agricultural production system in Babai irrigation system.

Agricultural performances of individual farmers have been analyzed based on typology, land holding size and location of farmers. The cropping strategy, cropping system, crop intensity were taken in to account to analyze agricultural performance. The typology, location and land holding size proves robust and significantly explains differences in crop production and yield. Crop yield of paddy (3.8 ton/ha), wheat (3.2 ton/ha) and Maize (2.1 ton/ha) has been found slightly higher than district crop production average whereas; the yield of mustard (0.47 tons/ha), pulses (0.57 tons/ha) and potato (2.9 tons/ha) has been found lower in Babai irrigation system in this regard. Among the farmer groups, Type-I farmers have better performance in terms of crop production. It is noted that majority of the farmers have been shown better performance regarding crop production and they are proceeding in line with the production market.

Several factors affecting the management of irrigation schemes such as physical, institutional, Socio-economical and technical are considered to be more valuable for development and proper management of irrigation system on farmers level. The principal component analysis (PCA) was carried out to identify the essential interrelationships of the factors influencing farmers' participation in irrigation management. The operation and maintenance requirements of irrigation systems are highly influenced by the efficiently running of physical facilities. Weak physical capacities have caused to need a higher administrative input that is why more participation of farmers is required during the operation as well as maintenance of the scheme. The provision of irrigation services has been evaluated in terms of adequacy and reliability of water availability. It has been noticed that the organizational rules and regulations were performing effectively in the summer season of crop cultivation only. Normally, the distribution is practiced on rotational basis in the irrigation system that is leading to inadequate supply of water.

The most critical factor influencing the whole performance of irrigated agriculture in Babai irrigation system is the vulnerability of the headwork. Definite support for upholding of the headwork should be continued for effective administration of BIP. Majority of the farmers especially in the tail region of the irrigation system are not receiving appropriate amount of water when needed. The poor maintenance of water courses, faulty conveyance system and poor control structures are the main reasons for such situation.

The people from the Babai Irrigation system were found to be usually participating behavior. It is concluded that farmers from different regions of Babai irrigation system are participating with a great zeal in different development activities. Majority of farmers has perceived benefits of implementing the idea of participation of farmers in irrigation

management for the system improvement. The study has exposed that the performance of water users associations has been unproductive so far. Water users associations have not been succeed in the supply of required irrigation water for the farmers, mainly in the lower reaches of the system. The response of farmers to water users association has been found to have a direct relationship with the availability of irrigation water.

Presently the farmers from BIS are paying on an average about 120 Rs. Per hectare as their contribution in maintenance of the irrigation system. The participation and contribution of the farmers in operational activities of the system is significantly higher and effective. More than 77 percent of farmers expressed that they are willing to pay more water charge in case of efficient water availability and relevant services. From the analysis it has been found that 28 percent of farmers from BIS have expressed their ability to operate the system except headwork. Similarly, 13 percent of farmers have expressed their ability to operate the whole system. All the farmers from BIS have expressed different level of willingness and ability to participate in operation and maintenance of the system.

8.2 Recommendations

The Babai irrigation system is an irrigation organization in which water users association is generally involved in water management behavior. Farmers get water on the basis of availability in source. There is obligatory schedule and distribution is supply oriented. Most of farmers are involved in subsistence farming. Therefore it has become essential for them to expand and diversify activities. The analysis of this study shows that intensification and diversification of different crops has been found to be the corridor for farmer's economic improvements. In this circumstance, subsistence farmers should strengthen their farming through profitable crops to improve their livelihoods.

Despite good access to road and market center farm households in the BIS was not commercialized as expected. It was mainly related to lack of knowledge and motivation on commercialized farming. Hence, the focus of extension program should be to initiate different extension activities that motivate farm households make best use of irrigation and other facilities for commercialized farming to increase income from irrigated farming and also to increase performance of irrigation system.

Farmers' participation in operation and maintenance of BIS can be boosted by increasing their involvement in decision making process of the operation and maintenance activities especially in distribution and allocation of water and setting the priorities of maintenance activities may develop the feeling of ownership of the system and eventually encourage farmers to par take in irrigation management. Incentives such as increased agricultural extension services, inputs and technical support to the farmers, training to the farmers, and beaurocratic re-orientation of agency personnel can play a major role in increasing farmer's involvement in O&M of the irrigation system. The most critical factor influencing the whole performance of irrigated agriculture in Babai irrigation system is the vulnerability of the headwork. Definite support for upholding of the headwork should be continued for effective administration of BIP.

Collective action in the scheme is only possible from effective participation of farmers at all level. Farmers are also responsible for having low fee collection ratio. So farmers requires to think more collectively than only having concern about their own business. Interest and support of Government in operation and maintenance of irrigation systems can

be incentive as well as disincentive for the participation of the farmers in irrigation management activities. WUA is mainly concerned in water distribution. It is crucial to diverse its activities to additional area. Farmers are not much satisfied with the WUA's rewarding and punishing mechanism. In this perspective other local institute will be a serving hand to WUA to apply this kind of activities to generate awareness.

More attention should be given to the monitoring of water distribution and irrigation service fee collection. Operational measures should be developed for dependable supply and impartial distribution of irrigation water. The responsibility of monitoring and implementation of such methods should be transferred to the farmers. The efficiency of organization of the farmers can be enhanced by regular monitoring and support from the agency and provide proper training to the farmers. The eagerness of the farmers to participate in the management activities varies with the nature of the responsibility. Gradual transferring of the operational and maintenance responsibilities of minor physical components to the major components may improve the farmer's participation.

According to the new government irrigation policy responsibility of collecting water charge would be given to the water users group and 75 percent of that collected amount would turn over to DOI for the maintenance of main irrigation system and the remaining amount can be used by the farmers' organization for activities of local maintenance. The available irrigation services should be considered in charging water tax to the farmers in O & M of irrigation system. Farmer's organization should be involved in the assessment and collection of water tax from the users of irrigation system. Direct spending of collected water charge in operation and maintenance activities would give confidence to the farmers to pay water tax in-time and the government's burden would be reduced.

The fund allocation for operation and maintenance activities should be based on the requirement of the system. Crystal-clear criteria should be made for the assessment of maintenance requirements and fund allocation for different sizes and types of irrigation systems. The involvement of farmers group should be assured completely in the construction and transparency of accounts and maintenance of all financial transactions.

Farmers' involvement is made obligatory in new irrigation strategy of government in planning, implementation and construction of new irrigation projects, and in rehabilitation of previous projects of irrigation as well. Significant investment of time for training and organizing the farmers, flexibility in construction work timings considering the agricultural activities of the farmers are required for considerable and fruitful participation. It can be concluded that the united efforts by the farmers can play a vital role in the improvement of irrigation system, which is expected to happen in the future.

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APPENDICES

Appendix-A
Asian Institute of Technology
School of Environment and Resources Development-SERD
Natural Resource Management

Questionnaire: "Factors and impacts of participation in operation and maintenance of Irrigation water management in Nepal"

This questionnaire is a section of thesis intending to analyze your perception regarding "factors and impacts of participation in operation and maintenance of Irrigation water management in Nepal". Your views and information obtained will remain strictly confidential and used only for academic purposes of this study, as mentioned above. Additionally, questions related to your household, agricultural activities, procedures of operation and maintenance related activities and your ideas about those activities. You will be also asked about your participation in O&M of irrigation scheme. The valuable views will be helpful to make some recommendation to further improve the irrigation system

1. General Information

Date	
Interview Ref. no.	

Name of interviewer:……. Household code: …….. …….

Address:……..…….

Particular	Location
Zone	
District	
Name of the irrigation system	
Village Development Committee	
Ward no.	

2. Ideographic Data of the Respondent

Age	(……) years
Gender	Male ( ) Female ( )
Education	Illiterate ( ) Primary ( ) Secondary ( ) Higher ( )

3. Household Composition

Name	Gender	Age	Main Occupation
1. Head			
2. Spouse			
3. Children in total			
4. Household member (adults & Children)			
5. Children < 14 in household			
	Male: Female:		

4. Land tenure and agriculture

Ownership pattern	Khet (Low land)		Bari (Upland)	Others*
	Irrigated	Rain fed		
Owner cultivated				
Rented in				
Rented out				
Total cultivated				

4.1. Since how many years, you are living here? Year……..

4.2. Do you pay some kind of land charges? Yes ( ) No ( )

4.3. If you pay then how much? Rs. ( ) Per …… To whom? ……..

4.4. Do you pay for irrigation services? Yes ( ) No ( )

4.5. If you pay then how much? Rs. ( ) Per …… To whom? ……..

5. Cropping System

Crop	Khet (Low land)						Bari (Upland)		Qty sold	Price/ unit	Qty. Consumed
	Fully Irrigated		Partially irrigated		Rained						
	Area	Prod.	Area	Prod.	Area	Prod	Area	Prod.			

6. Farm expenditures/ Production cost

Crop name	Input type 1. Fertilizer 2. Seeds 3. Herbicides 4. Pesticides 5. Labour 6. Tillage 7. Other	Supplier 1. Local shop 2. Store in town 3. Coop. 4. Individual (friend neighbor…)	Qty purchased (and used)	Cost per unit	Input market Description: distance, organisation	Marketing costs Transport Packaging Other
1	1 2 3 4 5					
2.	1 2 3 4 5					

6.1 Do you have any major agricultural equipment (eg. Tractor, Bakkie, implements)

Yes ( ) No ( )

6.2 If yes which……

6.3 If no, then do you hire them from others?

Yes ( ) No ( )

6.4 If yes, then how much you pay rent?.....

6.5 Can you quantify how much you are earning from them? (On average)
……..……..

7. Crop Calender

Crop	Jan	Feb.	Mar.	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1												
2												
3												
4												
5												

8. Other source of income

8.1 What is your income level per year from other agricultural products?

Source	Income in Rs.
Milk and products	
Sale of manure	
Sale of livestock alive	
Others (If any)…….	

8.2 What is your income level per year from off-farm and non-farm activities?

Source	Income in Rs.
Rent (Land, house, equipment, vehicles etc.)	
Business (Shop and others)	
Regular income (Pension, remittance)	
Permanent off-farm wage and salary	
Temporary off-farm wage and others	
Others (if any)……	

9. Socio-economic organizations

9.1 Are any of your family members serving in any formal or informal organization?

Yes ( ) No ( )

9.2 If yes, then, in which organization and what is the nature of involvement and contribution in that organization?

Organization	Involvement		Contribution (Cash, kind , Labor, Other)
	Ordinary	active	
Co-operatives			
Water user's			
School advisory			
Religious			
Social			
Other (if any)……....			

9.3 Why you joined organization?

Self interest ( ) Social obligation ( )
Pressurized by others ( ) Expecting benefit ( )

9.4. If not, why you did not join the organization?

No time ( ) No interest ( )
No benefit ( ) Dissatisfaction ( )

10. Conflict and conflict resolution

10.1 How much social and other conflicts occur in your area?

Too much ( ) Sometimes ( )
Seldom ( ) Never ( )

10.2 In your opinion, what is key reason of these conflicts?

Irrigation related ( )
Encroachment of land ( )
Inheritance ( )
Others ( )

10.3 What do you think, who are mostly involved in conflicts?

Individuals ( )
Households ( )
Group of people ( )
Villages ( )

10.4 Who solved those conflicts?

Mutual understanding between the involved ones ( )
By intervention of elders in the village ( )
By intervention of WUO or other organization ( )
By intervention of police and/ or court ( )

11. Irrigation system and delivery services

11.1 What is location of your farm with respect to main canal?

Head ( ) Middle ( ) Tail ( )

11.2 What is the name of your branch canal?
……..

11.3 What is location of your farm with respect to branch canal?

Head ( ) Middle ( ) Tail ( )

11.4 What is the distance from main intake to branch intake that supplies water to your field?
…….. Meters.

11.5 How much is the distance of your field from the outlet?

…… . Meters

11.6 How much is the distance of your branch intake to sub branch off take?

……..meters

11.7 How much area irrigated for different crops?

Crops	Total area cultivated (in Bigha)	Area receiving irrigation (in bigha)	Av. Frequency (in number)	Av. Coverage in percent of area (cultivated)
Paddy (Summer)				
Paddy (Winter)				
Wheat				
Maize (Summer)				
Maize (Winter)				
Mustard				
Pulses				
Potato				
Others (Specify)				

11.8 Effectiveness of irrigation scheme

11.8.1 How would you perceive about the fairness of water allocation?

Never ( ) Rarely ( )
Sometimes ( ) Usually ( )

11.8.2 How would you perceive about the reliability of water supply?

Always ( ) Usually ( )

Only sometimes ( ) rarely ( )

11.8.3 How would you perceive about the availability of water supply?

Always sufficient ( ) usually sufficient ( )
Sometime insufficient ( ) usually insufficient ( )

11.8.4 What do you think about the design and construction of the irrigation system?

Very well: no problem ( ) So-So: minor problem ( )
Not well: Some problem ( ) terrible: many problems ( )

11.8.5 Do you have any interruption in the delivery of water?

Usually ( ) Sometimes ( )
Seldom ( ) Never ( )

11.8.6 At which level of the system, mostly interruption occurs?

Headwork's ( ) Main system ( )
Branch system ( ) On-farm system ( )

11.8.7 What is your satisfaction level regarding following operational activities?

Activities	**Level of satisfaction**			
	Highly satisfied	**fairly satisfied**	**Not much satisfied**	**Dissatisfied**
Acquisition of water				
Allocation among branches				
Distribution among farmers				
Application of water in field				

11.8.8 What is your perception about the adequacy of maintenance?

Adequate ( ) So-So ( )
Not adequate ( ) completely inadequate ( )

11.8.9 In which level, you would prioritize the maintenance?

Headwork's ( ) Main system ( )
Branch system ( ) On-farm system ( )

11.8.10 In your opinion, what is the condition and performance of physical components of the irrigation scheme?

Particulars	Rating			
	Excellent	Good	Poor	Very poor
Headwork				
Main system				
Branch system				
On-farm system				

12. Irrigation organization

12.1 Is there any water user organization in your irrigation scheme?

Yes ( ) No ( )

12.2 If yes, have you introduction of president and secretary of present water user association?

Yes ( ) No ( )

12.3 Does WUA arrange meetings regularly?

Yes ( ) No ( )

12.4 If yes, how many times?

Once a month ( ) Once in two or four months ( )
Once in four to six month ( ) Once a year ( )

12.5 How frequently do you correspond with the executive committee of WUA regarding different activities?

Usually Sometimes ( )
Rarely Never ( )

12.6 What do you think about the effectiveness of water user association in different activities?

Activities	Effectiveness			
	Highly efficient	So-So	Not much efficient	Completely inefficient
Allocation & distribution of water				
Maintenance of the system				
Resource mobilization in the system				
Conflict management				

13. Participation

13.1 Do you involve in different development activities?

Yes ( ) No ( )

13.2 If yes, then at what stage, you are involved in different development activities?

Development projects	Stage of development			
	Concept	Planning	Implement	O&M
Irrigation				
Water supply				
School				
Road				
Other				

13.3 What is the frequency of your participation in different social activities?

Social activity	Frequency of participation			
	Always	Often	Sometimes	Rarely
Construction/ Development activities				
Campaign (aforestation, Sanitary, health)				
Social and religious events				

13.4 Do you contribute in different activities?

Yes ( ) No ( )

13.5 If yes, what is the contribution you do in following activities?

Activity	Contribution			
	Cash	Kind	Labor	Other
Construction/Development				
Campaign				
Social events and ceremony				

13.6 How do you contributed in the different implementing activities?

System level	Type of contribution			
	Cash	Kind	Labor	Other
Headwork				
Main system				
Branch system				
On-farm system				

13.7 If you participated in implementation stage then, at what phase?

System level	Phase of development			
	Planning	Implement	Operation	Maintenance
Headwork				
Main system				
Branch system				
On-farm system				

13.8 Participation in O&M of irrigation scheme

13.8.1 What do you think about the fairness of the system regarding your efforts?

Very well ( ) O.K. ( )
Somewhat unfair ( ) totally unfair ( )

13.8.2 How much you contribute in O&M of the scheme from your family?

Cash:…….. In Rs
Labor: ……in equivalent amount in Rs.
Kind:……. ……in equivalent amount in Rs.
Others:…… in equivalent amount in Rs.

13.8.3 How frequently, your family involved in O&M of irrigation scheme in previous Year?

Regularly ( ) Sometimes ( )
Seldom ( ) Never ( )

13.9 Willingness to participate

13.9.1 How much do you support for the transfer of the O&M responsibilities to the water users?

Strongly support ( ) fairly support ( )
Do not support ( ) strongly protest ( )

13.9.2 What is your perception about the farmer's ability to operate the different levels of irrigation system?

i) Complete irrigation system ( )
ii) Except Headwork ( )
iii) Branch system and on-farm system ( )
iv) Only on-farm system ( )

13.9.3 What is your level of willingness to participate in O&M?
Highly ( ) Fairly ( )
Not much ( ) Not at all ( )

13.9.4 How much your families contribute to operate the irrigation system, in case of no external support?

Cash:…… in Rs.
Labor……... in equivalent amount in Rs.
Kind:…… in equivalent amount in Rs
Others:…….. In equivalent amount in Rs

13.9.5 How much do you need external assistance for proper O&M of the irrigation system?

Highly ( ) Fairly ( )
Not much ( ) Not at all ( )

13.9.6 What is your opinion about the statement that the basic reason for non-cooperation is jealousy?

Strongly agree ( ) Agree ( )
Disagree ( ) Strongly disagree ( )

14. Role and involvement of government agency

14.1 What is your satisfaction level about the related authorities in O&M of the irrigation scheme?

Highly satisfied ( ) so- so ( )
Not satisfied ( ) totally dissatisfied ( )

14.2 What is your perception about the adequacy of agricultural support from concerned authorities?

Sufficient ( ) So- So ( )
Not much ( ) Insufficient ( )

14.3 What is your perception about the availability of the credit facilities from the government (if you need)?

Always ( ) Usually ( )
Sometimes ( ) Rarely ( )

14.4 What do you think about the support from government regarding agricultural inputs (fertilizers, seeds and pesticides) when required?

Always ( ) Usually ( )
Sometimes ( ) Rarely ( )

14.5 What is the adequacy level of provision of assistance and resources by the government for O&M of this irrigation scheme?

Sufficient ( ) So- So ( )
Not much ( ) Insufficient ( )

14.6 How often, concerned officials communicate with you about O&M of this irrigation system?

Usually ( ) Sometimes ( )
Few times ( ) rarely ( )

15. Irrigation Service fees

15.1 How much you are willing to pay (in Rs per bigha) as Irrigation water charge, if you get adequate and reliable supply of irrigation water?
……..

15.2 Do you pay water charges?

Yes ( ) No ( )

15.3 If yes, how much do you pay annually?

……. In Rs.

15.4 What is your perception about the fairness of water charge, you pay in terms of receiving water services?

Very well ( ) so- so ( )
Not fair ( ) totally unfair ( )

15.5 If you get more adequate and reliable water service, how much you can pay than existing water charges?

Not more than existing charge 20% more
50% more 100% more

16. What is your recommendation and suggestions for the improvement of the irrigation system for higher agricultural productivity?

1. _____

2. _____

3. _____

"Thank you very much for your cooperation"

<u>Appendix- B</u> Checklist for focus group discussion

Researcher's Name……. Date:……..

- Institution or organization Name
- Establishment year
- Organization legality
- Formation process
- Organization structure
- Cropping pattern
- Input supply in farm
- Market outlet
- Rate of crop selling
- Water adequacy
- Water schedule
- Water equality in supply
- Rules and regulation followed by farmers
- Clear and unbiased rules
- Conflict resolution
- Involvement of users in decision making
- Irrigation water charge
- Irrigation service fee and trouble of economy to users
- Is water charge enough to canal maintenance
- Training
- Major problem in system
- Comments and suggestions

APPENDIX C- SUPPLEMENTARY TABLES

Table C.1 Farmer response on equity of water supply against location

Level of satisfaction	Head	Middle	Tail	Overall
Very good	2 4%	4 8%	0 0%	6 4%
Satisfactory	37 80%	34 71%	27 68%	98 73%
Not satisfactory	5 11%	8 17%	8 20%	21 16%
Poor	2 4%	2 4%	5 12%	9 7%
Total	46 100%	48 100%	40 100%	134 100%

Chi square value=7.956; df=6; P=0.241

Table C.2 Opinion of farmers about the statement that the basic reason for non-cooperation is jealousy prevalent among farmers

Response	Farmer types				Overall
	Type-I farmer	Type-II Farmer	Type-III Farmer	Type-IV Farmer	
Strongly agree	12 13%	1 6%	3 17%	0 0%	16 12%
Agree	62 67%	6 38%	9 50%	4 57%	81 60%
Disagree	13 14%	8 50%	4 22%	2 29%	27 20%
Strongly disagree	6 6%	1 6%	2 11%	1 14%	10 7%
Total	93 100%	16 100%	18 100%	7 100%	134 100%

Chi-Square value=14.040; df=9; P=0.121

Table C.3: Result shown Principal Component analysis (PCA) with varimax rotation and Kaisar Normalization for sixteen household contextual variables. Numbers in bold refer to dominant variables for that component.

Variables	Component						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Ag. input provided by govt.	**-.801**	-.038	-.109	.061	.058	.006	.055
WUO Effective in maintenance	**.698**	-.194	-.061	-.020	.325	.194	.105
Participation in branch system	**.469**	.340	.079	.420	-.094	-.369	.085
Ag.credit provided by govt.	-.212	**.794**	-.079	-.248	.068	-.017	-.114
Age of the respondent	-.104	**-.720**	-.064	-.182	.064	-.080	-.044
Participation at headwork	.174	-.224	**.795**	-.156	.004	-.200	.101
Assistance provided by govt.	-.327	.098	**.709**	.286	.072	.268	-.066
Extension service by govt.	.217	.290	**.568**	.289	.185	-.004	.011
WUO Effective in conflict mgt.	.003	.054	.121	**.807**	-.140	.081	.082
Participation in O&M	.331	.275	-.020	**.495**	-.262	-.136	-.105
Participation at main system	-.184	.017	-.065	-.061	**-.769**	-.173	.042
Participation on dev. Activities	-.106	.017	.089	-.148	**.721**	-.259	.103
WUO effective in Resource mob.	-.044	-.052	-.090	.277	.086	**.808**	-.093
Household numbers	.247	.273	.146	-.237	-.259	**.632**	.125
Location of respondents	-.105	.062	-.019	-.019	.141	-.026	**.827**
WUO effective allocation &dist.	.128	-.106	.065	.152	-.090	-.007	**.790**
Eigen values	**2.14**	**1.85**	**1.78**	**1.48**	**1.40**	**1.21**	**1.04**
%variance	**13.345**	**11.537**	**11.120**	**9.221**	**8.775**	**7.591**	**6.521**
% Cumulative	**13.345**	**24.882**	**36.002**	**45.222**	**53.998**	**61.589**	**68.110**

Table C.4 Temperature, relative humidity and sunshine hours of the nearest station (Nepalgunj)

Description	Unit	January	February	March	April	May	June	July	August	September	October	November	December
T_{max}	°C	20	25	31	36	38	36	34	33	33	32	28	23
T_{min}	°C	9	11	16	21	25	27	27	26	25	21	15	11
RH_{max}	%	93	88	78	62	66	78	88	91	91	89	89	92
RH_{min}	%	71	60	46	39	49	59	77	80	79	72	63	68
Sunshine	H/day	5	8	8	9	10	7	6	5	6	8	7	7

Source: DHM, 2006. T_{max}: average maximum temperature.T_{min}: average minimum temperature.RH_{max}: average maximum relative humidity.RH_{min}: average minimum relative humidity.

Table C. 5 Relationship among WUA and government agency

Relationship between WUA and agency	Head	Middle	Tail	Overall
Very good	3 7%	7 15%	2 5%	12 9%
Satisfactory	33 72%	26 54%	24 60%	83 62%
Not satisfactory	4 9%	8 17%	12 30%	24 18%
Poor	6 13%	7 15%	2 5%	15 11%
Total	46 100%	48 100%	40 100%	134 100%

Chi- square value=11.397, df=6, P=0.077